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INDUCED SPREADING PERITONITIS COMPLICATING ACUTE PERFORATIVE APPENDICITIS

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PERITONITIS causes 92 per cent of the deaths of patients admitted to hospitals with a diagnosis of acute appendicitis. Of these deaths, according to the surgeons who operated or the physicians who wrote the gross findings, [1] 81.7 per cent were due to spreading peritonitis; 10.4 per cent to local peritonitis, and 7.9 per cent to other causes. Deaths under the caption "Due to Other Causes" will not be discussed—the number is practically constant from year to year and includes catastrophes, deaths due to anesthetics, hemorrhage, cardiac dilatation, embolism, atelectasis, pneumonia, etc.

Deaths under the caption "Local Peritonitis," however, will be discussed in detail. Of each 100 patients admitted to hospitals with a diagnosis of acute appendicitis, between 15 and 20 have a localized abscess. These patients are usually operated upon within 24 hours; following operation, however, a number far in excess of what the average surgeon would consider moderate, develop hyperpyrexia or tachycardia and some of them die. A careful study of the clinical records of these patients shows that those who recovered had a stormy and protracted convalescence. The cause of death written by the interne was, with very few exceptions, local peritonitis, the diagnosis on admission. We call this Group I—Operative-Induced Spreading Peritonitis.

A second group of patients, approximately 89 per cent of those admitted to the hospital with spreading peritonitis complicating acute

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[1] From the analysis of 18,687 cases admitted to 28 hospitals in Philadelphia over a period of 6 years.

Plate I. A, Normal peritoneal cavity, living dog. Note large left lobe of liver; robin's egg blue of gall bladder; visceral peritoneum, light pinkish gray; parietal peritoneum, ileum, pinkish gray; omentum uniformly distributed covering large and small intestine. B, Twenty-four hour local peritonitis, no laxative. Appendix and mesentery ligated. Demonstrates omental quarantine of distended gangrenous appendix. Visceral peritoneum slightly injected; parietal peritoneum, unprotected loops of ileum, show dark pink injection. C, Twenty-four hour spreading peritonitis, no laxative. Appendix and mesentery ligated; visceral peritoneum hyperemic; parietal peritoneum, ileum, injected, vessels prominent, slightly distended. Stomach vessels injected, slightly distended. Liver displaced upward; omentum uniformly distributed over viscera. Exudate seropurulent. D, Twenty-four hour peritonitis, *laxative induced*. Appendix and mesentery ligated and 30 cubic centimeters of castor oil given immediately after operation. Parietal peritoneum intensely injected; visceral peritoneum, ileum, compare with lower left; loops distended in upper abdomen; stomach injected, marked increase in size of gastro-epiploic vessels. Omentum attempting to localize process; it extends from left lower to upper right between coils of ileum; exudate purulent.

perforative appendicitis, had received one or more than one laxative. The mortality of this group of patients was 115 per cent higher than that of the group that had not received laxatives. This is Group II—Laxative-Induced Spreading Peritonitis.

Deaths in a third group of patients occurred because of a reactivation of the infectious process induced through errors in judgment in the management following operation. This is Group III—Postoperative-Induced Spreading Peritonitis.

GROUP I—OPERATIVE-INDUCED SPREADING PERITONITIS

Factors mainly responsible for its induction are:

1. Failure to diagnose before operation the localizing process;
2. Failure to recognize the localizing process at operation;
3. Radical surgery.

1. Failure to diagnose before operation the localizing process. A clinical pathological classification of acute appendicitis and peritonitis based on correlation of symptoms and signs, gross findings at operation and what happens to the patient after operation, will be reported elsewhere. The important addition to the generally accepted pathological classification—acute appendicitis, spreading peritonitis, and local abscess—is the localizing process, the potential or retrogressive spreading process.

Perforations of the appendix are either acute or subacute. The stage of transition between an intact serosa and perforation with spreading peritonitis in the acute fulminating type of appendicitis is minimal in point of time. The symptoms and signs, however, are usually consistently progressive; only occasionally because an excessive amount of antigen escapes through the perforation into the peritoneal cavity, do the symptoms and signs of perforation alone dominate the clinical picture. In subacute perforations, however, the symptoms and signs associated with rupture of the serous coat are minimal because the local tissue changes preceding and following it are designed by nature to limit the dose of antigen to an amount commensurate with the reactive capacity of the patient. Before perforation, the deposition of fibrin upon the serous coat, swelling of the endothelial cells and the subserous mobilization of neutrophils tend to thicken and strengthen the wall of the appendix. These changes are accompanied by an increase of intra-appendiceal pressure which continues as long as the serous coat remains viable. When the cells composing this membrane die, the serous coat becomes separated from the gangrenous tissue beneath and intra-appendiceal tension is diminished. At this point symptoms and signs previously present may disappear—it is the "lucid interval" (1). Absorption of antigen during this period is minimal. When perforation occurs because of liquefaction necrosis and increased intra-appendiceal tension, the spread of the process may be prevented by plastic exudate, or by the parietal or visceral peritoneum or omentum. This is the localizing process (Fig. 1). The amount of antigen absorbed during this stage is also minimal. An analysis of this large number of clinical records shows that the average physician and surgeon invariably diagnose acute appendicitis and its chief complication, spreading peritonitis, when the process is fulminant or moderately active; the same is true of the local abscess. The surgeon and his associates, however, frequently fail not only to diagnose the localizing process but certain lesions which frequently precede its formation as well—partial or complete gangrene of the appendix which, as we have previously stated, is responsible for the lucid interval. Every death that occurred from appendicitis and its complications on my service in 3 hospitals during the past 4 years was due to failure of the operator to diagnose these lesions before operation. The diagnosis of the localizing process before operation is dependent to a great extent upon a complete account, written in detail, of what happens to the patient before he is admitted to the hospital. This must include not only questioning the patient but the physician who first sees him as well, which is especially important if the patient has had hypodermic injections. It should be emphasized that the physician who first sees a patient with an acute lesion of the abdomen, whether immediately or potentially surgical,

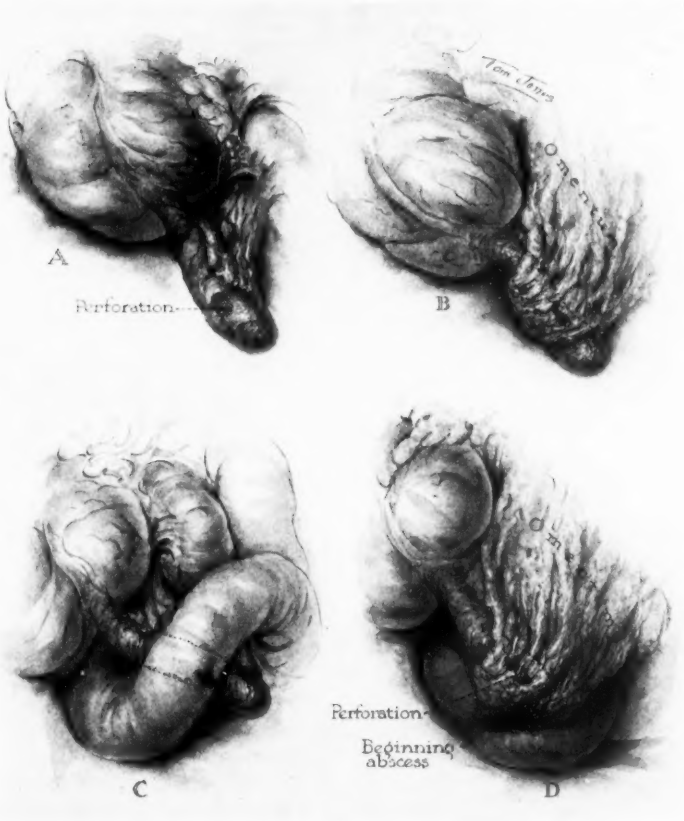
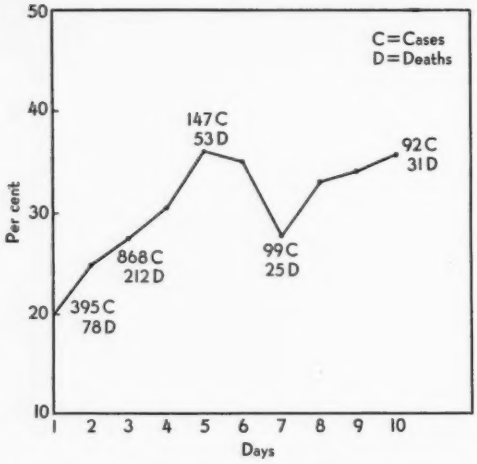


Fig. 1.

has the best opportunity to interpret correctly the tissue changes which have occurred intraperitoneally.

Pre-operative diagnosis is also dependent upon a careful clinical study and repeated physical examinations after the patient is admitted to the hospital. The process usually begins in the mucosa, progressing to a partial or extensive gangrene or an acute suppurative process followed by necrosis, which accounts for the fact that early symptoms and signs are usually typical of an appendiceal colic of moderate degree. General colic-like pains which later localize to the right lower quadrant, nausea and one or two attempts at vomiting are the usual symptoms. The presence or absence of tenderness and tenseness or rigidity of the abdominal muscles depends on the situation of the appendix. During the first 24 hours the temperature is usually not higher than 101 degrees; pulse between 90 and 100; leucocyte count around 12,000 with a preponderance of neutrophils.

If perforation has been preceded by gangrene, the lucid interval which accompanies it may be confused with resolution by the attending physician; the relief of pain and the absence of tenderness and rigidity accompanying perforation are due to diminished intra-appendiceal pressure; accompanying resolution, to the absorption of the products of inflammation in an intact appendix. A localiz-



Graph 1. Mortality of spreading peritonitis, 2,573 cases —24 hour groups, 1928–1933.

ing process in a resistant patient, when adequately Ochsnerized, may be at times completely absorbed. It is not uncommon for a surgeon to remove an appendix while operating for another lesion, that shows definite evidence of a previous perforation. Ochsnerization instituted in the home is usually incomplete, enforced only to the point of cessation of acute symptoms. Frequently tenderness is present when fluids are given by mouth. The physician may send the patient to the hospital at this time but on admission signs of an acute process may have disappeared. Whether at home or in the hospital, the prognosis is dependent upon whether a clinical pathologist is called in or whether something is given by mouth to stimulate peristalsis. If the clinical pathologist is consulted a catastrophe may be prevented; if a laxative is given a frank spreading peritonitis invariably develops.

The diagnosis of a localizing process which is progressing to abscess formation is usually not difficult if the physician or surgeon is thinking of the possibility of its existence. A vaginal or rectal examination should be made in addition to the abdominal examination and the results of each recorded. A word of caution regarding repeated abdominal examinations should be interpolated at this point. My associates and I have had the unpleasant experience of observing a rather obese female die following the conversion of a localized abscess into a spreading peritonitis by forceful manipulation. The safety of the patient is dependent in part upon repeated abdominal examinations, but they should be done deliberately and carefully; the patient should be requested to co-operate, the physician explaining that the opening of the mouth and the bending of the knees facilitates relaxation. The entire hand of the examiner should be placed gently on the abdomen, pressure being exerted only with the tips of the fingers.

2. *Failure to recognize the localizing process at operation.* Because of the gradual development of the localizing process, gross tissue changes are not marked, at least those visible through the average abdominal incision. The preperitoneal tissues are edematous and if the incision has been made over or near the lesion the parietal peritoneum will be injected—the degree of hyperemia of the visceral peritoneum will depend upon the time that has elapsed between perforation and operation. Free fluid, if present, is usually moderate in amount, cloudy, seropurulent, and slightly odorous. A smear may show micro-organisms; cultures frequently do. If rupture occurs in an appendix which has previously been involved in an infectious process, the accompanying appendiceal fibrosis and periappendiceal adhesions diminish absorption, and hyperemia of the peritoneum and transudation of fluids will be comparatively less. If the process is in close proximity to the incision, it can be visualized and recognized without difficulty. Coils of distended small intestine, cecum or thickened omentum, however, may make visibility difficult. Perhaps the most important pathological finding which may lead one to suspect a concealed perforation is the marked thickening of the omentum caused by the increased vascularity, edema, neutrophilic and clasmatocytic infiltration. The foregoing is all that can be seen through a transverse or muscle-splitting incision.

3. *Radical surgery.* A surgeon's mortality percentage is dependent to a great extent not only upon the number of cases he has managed

but on whether he has profited by the mistakes he has made as well. Without exception, there is no lesion of the abdomen requiring surgery in which errors of commission influence mortality so markedly as in spreading peritonitis complicating acute perforative appendicitis. Errors of omission are not so death dealing—if the patient with a localized abscess is left alone, he may absorb it—50 per cent of the dogs with appendiceal abscess following induced gangrene do. The old controversy as to whether immediate operation should be done or watchful waiting instituted has been definitely settled, in my opinion. Individuals recover or die from spreading peritonitis just as they do from a pneumonia or a spreading cellulitis because they do or do not develop a general and local tissue immunity. Doses of antigen, clasmatocytic response, and antitoxin formation are as important in one as the other.

Graph 1 shows the mortality of 2,573 patients operated upon for spreading peritonitis following a perforated appendix. They have been divided into 24 hour groups—the vertical column shows mortality percentage; the horizontal the day of the disease. You will observe that the mortality increases with each 24 hours up to the fifth day—there is a slight decrease on the sixth and a marked drop on the seventh day because general and local tissue immunity approach their maximum at that time. We have not found antitoxin in the blood of patients before the sixth day following perforation.

The important point in this discussion is the character of the reaction and the outcome of patients who are operated upon during the localizing stage. While the McBurney or muscle-splitting incision is made in less than 50 per cent of the acute cases, we will suppose that the operator suspects the possibility of rupture and that he selects this type of incision for obvious reasons. The peritoneal cavity reveals in part the gross findings described, but loops of intestine obstruct the surgeon's view. A small gauze pack is inserted and he attempts to quarantine the suspected process which he finally accomplishes but his vision is limited because of the small incision; after enlarging it, visibility is still only about

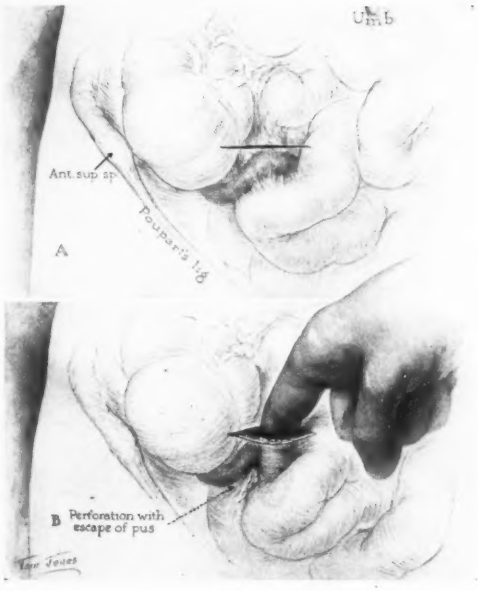


Fig. 2.

70 per cent. He is not sure whether the tip of the appendix adherent to the parietal peritoneum near the brim of the pelvis and surrounded by a loop of ileum is or is not perforated. Finally he separates the adherent tip from the peritoneum and purulent material exudes. The peritoneum has been well prepared for rapid absorption of antigen. Loops of ileum have been separated, fibrinous plaques have been brushed off, endothelial cells have been destroyed, exposing capillaries and lymph vessels. If at this point a drain is inserted, the gauze strips gently removed, a normal saline dressing applied and Ochsnerization instituted, 9 out of 10 patients will successfully combat the dose of antigen. But now that the operator has started he wants to finish the job and he removes the appendix. In a large number of instances death follows.

Perhaps the surgeon has not followed the procedure described; perhaps he has done something worse—not being able to visualize the process he may have placed an index finger into the wound and attempted to hook up the appendix—Figure 2 shows definitely what happens. One-twenty-millionth gram of crys-

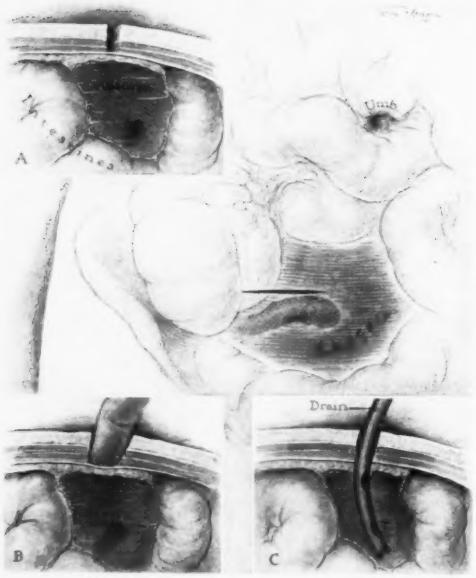


Fig. 3.

talline egg albumen is sufficient to stimulate antibody formation. How much antigen escapes into the peritoneal cavity from the average ruptured appendix? How much is absorbed from this gauze abraded area? This cannot be estimated at operation but the immediate postoperative response of the patient will tell—perhaps he will respond satisfactorily—80 per cent of them do but 20 per cent of them do not.

While the mortality of the localizing process is high, when the appendix is removed in the presence of a spreading process the mortality is still higher. Table I shows what occurred in 12 of the 28 hospitals in Philadelphia where radical surgery was practiced. The average time between onset of symptoms and operation was 58 hours; the mortality 37.4 per cent; the appendix was removed in 95.7 per cent of instances.

TABLE I

Hosp. No.	Spreading peritonitis			Appendix removed per cent	Average hours onset of symptoms and operation	
	Cases	Deaths	Mortality per cent		Recoveries	Deaths
7	10	4	40	77.7	64	31.7
10	4	1	25	100	56.6	14
12	21	5	23.8	100	50.4	79.2
15	12	8	66.6	90	42	44
17	2	2	100	100	0	97
19	39	11	26.1	100	69.9	42
21	15	4	26.6	100	59.1	33.2
22	21	7	33.3	95	61.5	50
24	7	2	28.5	100	48.7	114
25	17	8	46.5	80	71.9	92
26	20	10	50	93	40.9	54.2
28	3	2	66.6	100	38	78
	171	64	37.4	95.7	57 hrs.	58.4 hrs.

THE PREVENTION OF OPERATIVE-INDUCED SPREADING PERITONITIS

Anesthesia. When the patient is a good spinal anesthesia risk, and the anesthetist has had experience in the technique of induction and the management of patients who have had spinal anesthesia, it is ideal for opening an appendiceal abscess. The surgeon or anesthetist endeavoring to develop a spinal technique should not include patients with spreading peritonitis. If the diffusion of the anesthetic is too high and artificial respiration is resorted to, or carbon dioxide with oxygen is given under pressure, the excursions of the diaphragm and the passive movements of the accessory muscles of respiration will diffuse the process and increase absorption.

Advantages of spinal anesthesia are:

1. The accessory muscles of respiration and the transverse abdominal muscles are relaxed, thus permitting a maximum of visualization of the peritoneal cavity; in addition absorption is diminished because of the minimal excursions of the diaphragm and anterior abdominal wall.

2. The abscess can be outlined accurately by palpation and at times can be seen protruding above the normal contour of the abdomen.

3. The relaxed and more quiet abdomen permits a better preperitoneal palpation of the intraperitoneal abscess (see technique, Fig. 3B).

Spinal anesthesia increases peristalsis. In early spreading peritonitis, adherent loops of

intestine may be separated, which we have shown by cinema, taking place in the peritoneal cavity of dogs. The greater ease of accessibility diminishes the likelihood of rupturing the abscess wall which, in my opinion, more than offsets the effect of the toxemia induced by the increase in peristalsis produced by the spinal anesthesia.

Abdominal incision and preperitoneal palpation. The location and type of incision are determined by the situation of the abscess. In all instances an attempt is made to open the abscess from the roof. The advantage is twofold—drainage is simple and absorption is minimal, a single rubber tube only being required (Fig. 3C).

Figure 3 shows the method employed when the transverse incision is used. Following separation of the fibers of the internal oblique and transversalis muscles, the index finger palpates the mass beneath, no attempt being made to aspirate (Fig. 3B). If it is tense and resistant to the touch, the peritoneum is opened and a drainage tube is inserted into the abscess (Fig. 3C). Two small cigarette drains may be inserted, one on either side of the tube, to control oozing and permit the gradual withdrawing of the tube, thus reducing absorption to a minimum. The wound is not sutured; a safety pin is pierced through the tube and gauze is placed above and below so as to insure its being securely anchored by the retentive bandage.

When preperitoneal palpation with the index finger discloses a non-resisting mass (Fig. 4A), intestinal coils are undoubtedly present beneath, and another attempt should be made to locate that portion of the abdominal wall which the operator considers a more direct route to the roof of the abscess. Another incision is made and preperitoneal palpation again carried out. If it is located the first incision is closed and a tube inserted through the roof (Fig. 4B). If the surgeon discovers intestinal coils instead of an abscess, after the peritoneal cavity is opened, he should carefully insert his index finger and locate the wall; another incision should then be made over the roof after the first incision is closed; if the abscess cannot be definitely located by this method, the patient should be returned

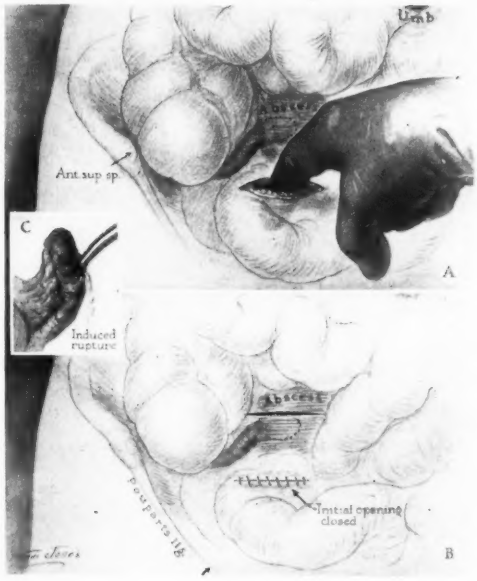


Fig. 4.

to the ward for further observation and Ochsnerization continued—frequently this type of abscess will be absorbed and appendectomy can be carried out at the end of 8 weeks.

Removal of appendix. The appendix is not removed in the presence of a localized abscess, or when an unsuspected localizing or spreading process is found at operation. The only exception to this is in spreading peritonitis when there is no evidence of localization and the perforated appendix is accessible; it is removed and a catheter is placed in the cecum.

The following abstract with graphic illustration (Graph 2) shows how a spreading peritonitis *should not* be managed.

Female, aged 21 years, had symptoms and signs of an acute surgical abdomen. "Results" (laxative) given 5 hours after onset of pain. Patient was admitted to the hospital and operated upon 30 hours after onset of symptoms; anesthetic: spinal neocaine and local novocain. A right rectus incision was used. The appendix was retroceal, and perforation was not recognized immediately. The appendix was removed and multiple drains were inserted. Eighty cubic centimeters of perfringens antitoxin in divided doses was given intramuscularly; glucose metabolic balance instituted; death in 5 days.

A spreading process was suspected but was not definitely diagnosed before operation. Spinal anesthesia was unsatisfactory. Death was due to two large doses of antigen, laxative before operation and search for and removal of appendix. Too radical surgery.

The following abstract with graphic illustration (Graph 3) shows how a *localizing process*—a laxative-induced retrogressing process—*should* be managed.

Female, aged 17 years, had symptoms and signs typical of spreading peritonitis. Citrate of magnesia was given 24 hours after the onset of symptoms. Patient was admitted to the hospital 72 hours after the onset of pain. She was given 100 cubic centimeters of perfringens antitoxin intramuscularly in 3 doses and continuous hypoclysis of normal saline. Patient held 5 days before operation. Spinal anesthesia, neocaine was used. Through a transverse incision the *localizing process was recognized but not disturbed.* A cigarette drain was inserted down to, but not into, the abscess cavity. Drain was removed on fifth postoperative day. Subsequent operation on nineteenth day after onset of symptoms—14 days after first operation—showed complete absorption of the appendix.

Glucose should have been given with the normal saline solution. A gauze drain would not have been necessary. Good judgment was shown in not disturbing a localizing process. One dose of antigen.

The following abstract with graphic illustration (Graph 4) shows the results of the failure to diagnose before operation the localizing process, and the disastrous results induced by simple drainage.

Male, aged 22 years, had symptoms and signs typical of acute appendicitis. An Ex-lax tablet was given immediately after the onset of pain. Patient was admitted to the hospital 48 hours after onset of symptoms and was operated upon immediately. Spinal anesthesia, neocaine was given. A transverse incision was made. The localizing process was not recognized until the pus exuded retrocecally. The appendix was not removed; rubber tube and cigarette drains were inserted—gauze quarantine drain was removed. Thirty cubic centimeters of perfringens antitoxin was given immediately and again in 24 hours, intramuscularly. An attempt was made to maintain the glucose metabolic balance. Symptoms and signs of spreading peritonitis diminished but patient developed pneumonia and died on twelfth postoperative day. Postmortem showed localized peritonitis.

This patient received two doses of antigen, laxative before operation, plus search for and opening of abscess. He should have been held until a localized abscess had developed.

GROUP II—LAXATIVE-INDUCED SPREADING PERITONITIS

Of the 2,578 patients admitted to hospitals in Philadelphia with spreading peritonitis complicating acute perforative appendicitis, 1,408 gave definite statements regarding laxative administration; 89.14 per cent had received laxatives. In this same group 153 had not received laxatives and 16, or 10.45 per cent, died; 1,119 received one laxative and 250, or 22.34 per cent, died; 136 received more than one laxative and 33, or 28.67 per cent, died.

These observations are not new; surgeons have known for many years that laxatives increase the incidence of spreading peritonitis and interfere with the possibility of localization, not only in perforation of the appendix but in acute lesions involving other abdominal viscera. Heretofore there has been no definite evidence, however, to show that a laxative-induced spreading peritonitis differs pathologically from a spreading peritonitis when laxatives have not been given. An inspection of the colored photographs (Plates I and II) will show more than any number of words can describe, the difference between spreading peritonitis that has and has not been induced

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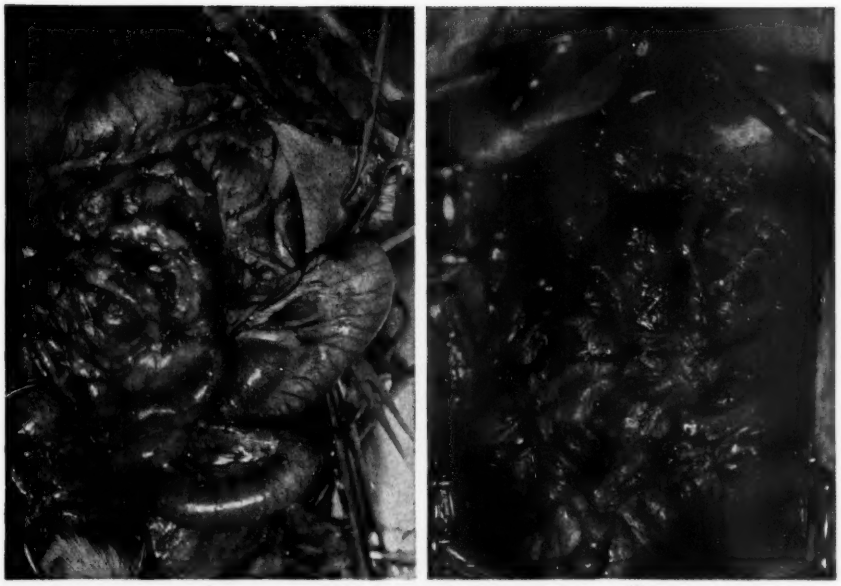
Plate II. A, Forty-eight hour spreading peritonitis, no laxative. Appendix and mesentery ligated; parietal peritoneum upper left, normal color; visceral peritoneum, ileum, blood vessels, more prominent; loops nearest focus of infection, brilliant red; stomach, normal color; omentum, lower right, localized over perforated appendix; exudate serous, slightly cloudy. B, Forty-eight hour *laxative induced* spreading peritonitis. Thirty cubic centimeters of castor oil given immediately after ligation of appendix and mesentery; parietal peritoneum light to dark mahogany; visceral peritoneum, compare with upper left; omentum not localized; lighter area in center crossed by large mesenteric veins, left to right; exudate hemorrhagic purulent. C, Seventy-two hour spreading peritonitis, no laxative. Appendix and mesentery ligated; parietal peritoneum more injected than upper right; visceral peritoneum, ileum injected, loops adherent, slightly distended; stomach not visible; omentum mobilized around the perforated appendix in left midabdomen; exudate hemorrhagic. D, Seventy-two hour *laxative induced* spreading peritonitis. Thirty cubic centimeters of castor oil given immediately after ligation of appendix and mesentery; parietal peritoneum dark red due to venous congestion; visceral peritoneum, ileum lusterless, no semblance of normal intestine; loop in hypergastric region cyanotic. Omentum disintegrated, beginning necrosis; exudate dark, purulent.



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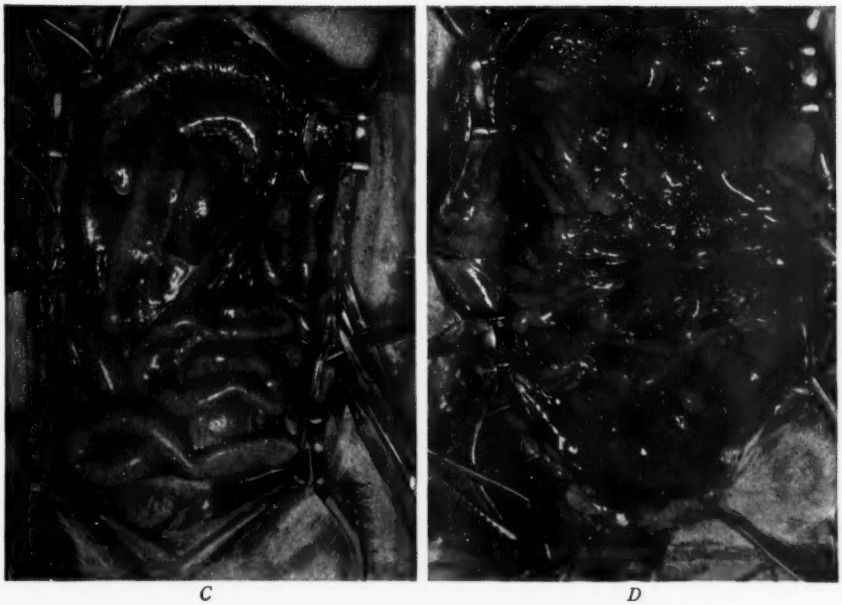

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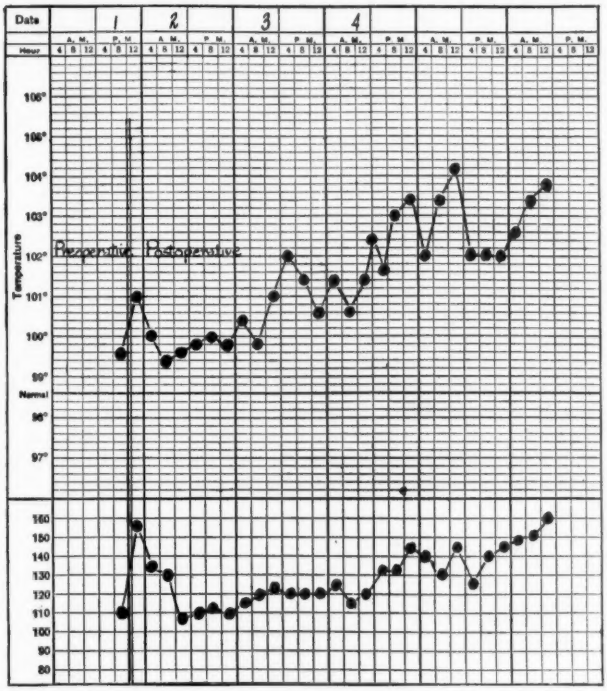
PLATE II

Induced Spreading Peritonitis Complicating Acute Perforative Appendicitis
John O. Bower, M.D., F.A.C.S., John C. Burns, M.D., and Harold K. Mengle, M.D.

(See legends on opposite page.)



Graph 2. Pulse and temperature charts in case of F. S. showing how a spreading peritonitis should not be handled.

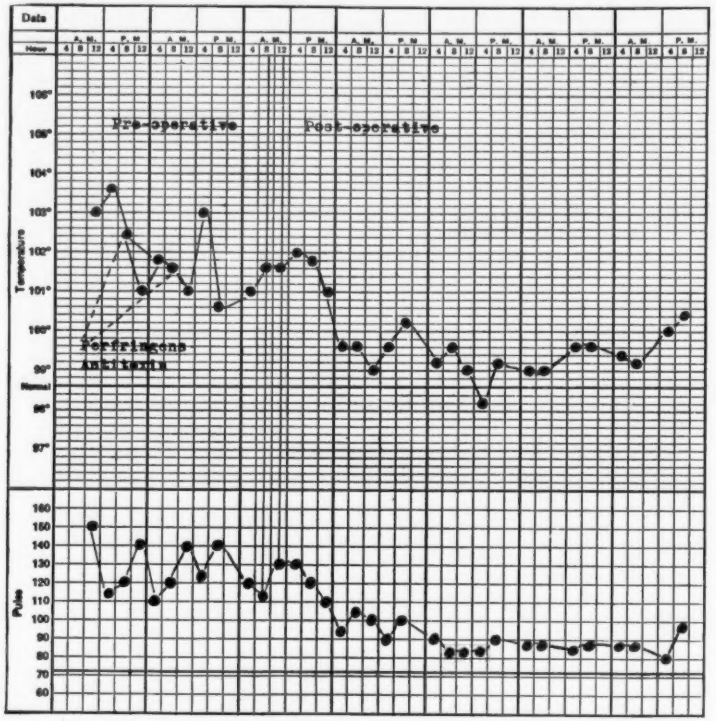
by laxatives. These photographs of the dog's peritoneal cavity were made before death of the animal: clinical investigations as well as our experimental work show that if man is treated similarly to these dogs he has 3 chances in 8 of dying in the same fashion.

EXPERIMENTAL WORK

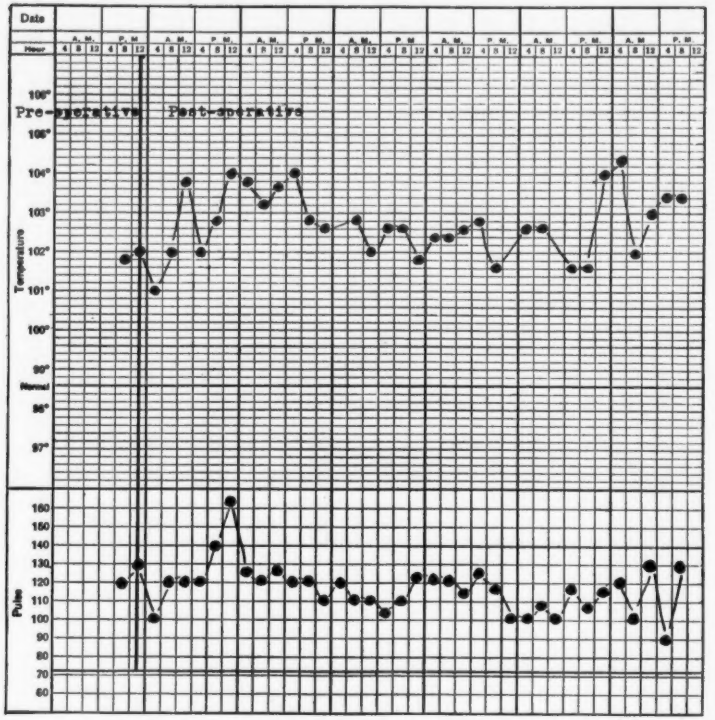
A summary of the experimental work conducted by Drs. J. C. Burns, H. A. Mengle and myself in the Department of Surgical Research, Temple University, is appended.

We ligated the base and mesentery of the appendix in a group of dogs. Fifty per cent of them developed a localized abscess and recovered and 50 per cent died of spreading peritonitis. In a second group of 54, the base of the appendix and the mesentery were ligated, 30 cubic centimeters of castor oil was given 24 hours after ligation and 68 per cent died of spreading peritonitis. To a fourth group of 12, 54 cubic centimeters of castor oil was given immediately after operation and 91 per cent died of spreading peritonitis. In a fifth group the appendix and its mesentery were ligated; laxatives administered. The animals were re-operated upon at varying periods of time and the peritoneal exudate studied bacteriologically. These findings, and the results of a study of the bacterial flora obtained from patients operated upon for spreading peritonitis complicating acute perforative appendicitis, together with a review of the literature have been reported (2). Our investigations showed that the aerobic bacterial flora in man and dog differed in that the colon bacillis was found only in 14 per cent in the dog as compared with 68 per cent in man. A study of the anaerobic flora showed that the Clostridium welchii was present in 60 per cent of instances in man and 63 per cent in the dog. These figures are practically the same as those of Weinberg.

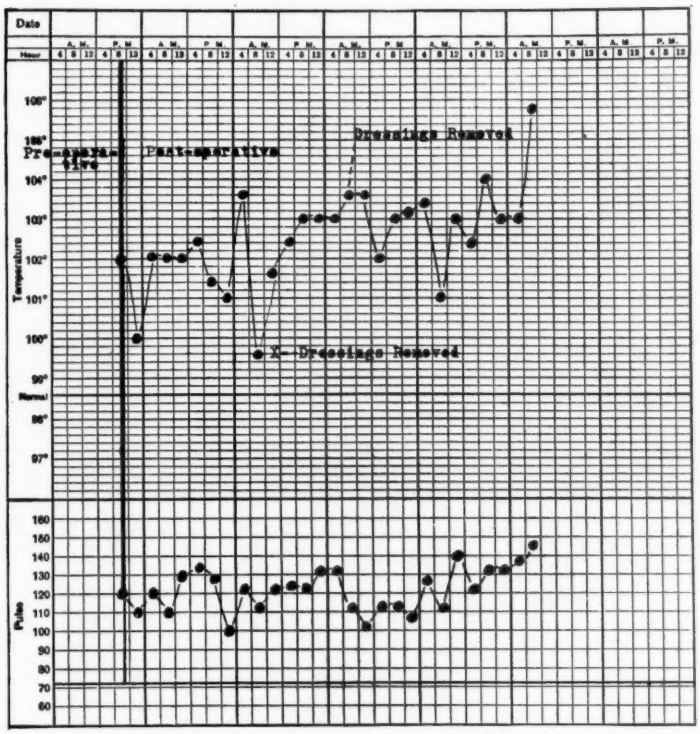
We then treated dogs that had an induced spreading peritonitis with perfringens antitoxin (Clostridium welchii). The mortality of the control group —89 dogs—was 74 per cent; of the treated group, 38 per cent. A second group was given horse serum—the mortality was 60 per cent; in a third group perfringens antitoxin combined with whole blood was given, mortality 33 per cent; in a fourth perfringens antitoxin combined with Bacillus coli serum, mor-



Graph 3. Pulse and temperature charts in case showing how localizing process should be managed.



Graph 4. Results of failure to diagnose the localizing process and of the use of drainage.



Graph 5. Effect of too early removal of drains.

tality 33 per cent; in a fifth, perfringens antitoxin combined with immune serum, mortality 33⅓ per cent; and finally lyophilized convalescent serum (serum removed from dogs that had recovered from a laxative-induced spreading peritonitis) was injected; in this group we obtained the lowest mortality—25 per cent (to be reported in detail elsewhere, 3). Following this animal experimentation, two groups of patients, over 90 per cent of whom had received laxatives and had had a frank spreading peritonitis due to a perforated appendix, were studied. They had been treated with perfringens antitoxin. The first group is made up of 31 patients who had been operated upon directly after admission, average 61 hours, and given perfringens antitoxin and glucose intravenously—with a mortality of 19.35 per cent. A second group, 35 patients, had been held and given perfringens antitoxin and glucose intravenously; localized abscess opened on seventh day—the mortality was 5.71 per cent.

Up to this point, we have shown that—

1. The incidence as well as the mortality of spreading peritonitis in both man and dog were increased by the administration of laxatives;

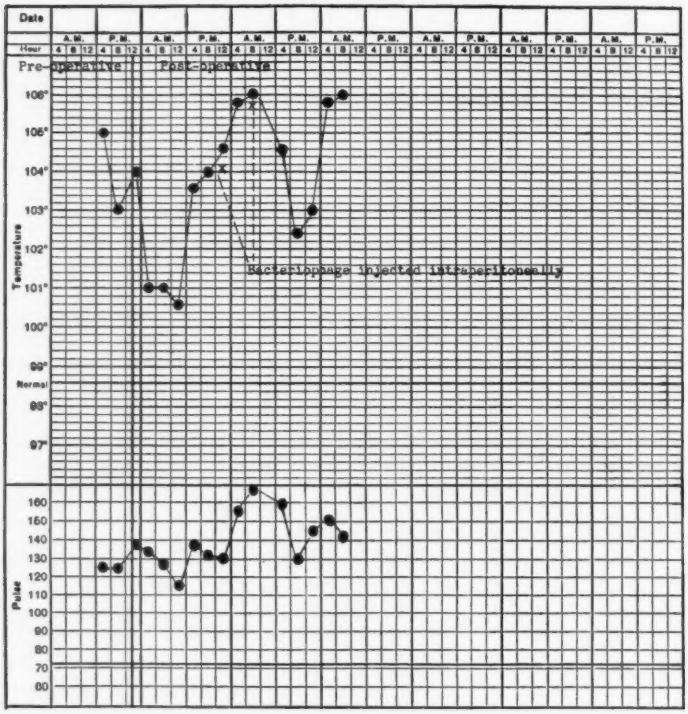
2. The time of administration and the dose of laxative influenced the mortality;

3. The Clostridium welchii was present in 60 per cent of instances in the flora of spreading peritonitis in man and dog;

4. The administration of perfringens antitoxin reduced the mortality of spreading peritonitis 122.52 per cent in man and 94.74 per cent in the dog;

5. Convalescent serum, lyophilized, was a factor in the low mortality of spreading peritonitis in both man (to be reported) and dog.

There remained but one discovery necessary to establish the proof and that was to find the antitoxin of the Clostridium welchii in the blood of patients who had recovered from spreading peritonitis due to a perforated appendix. This has been reported (4).



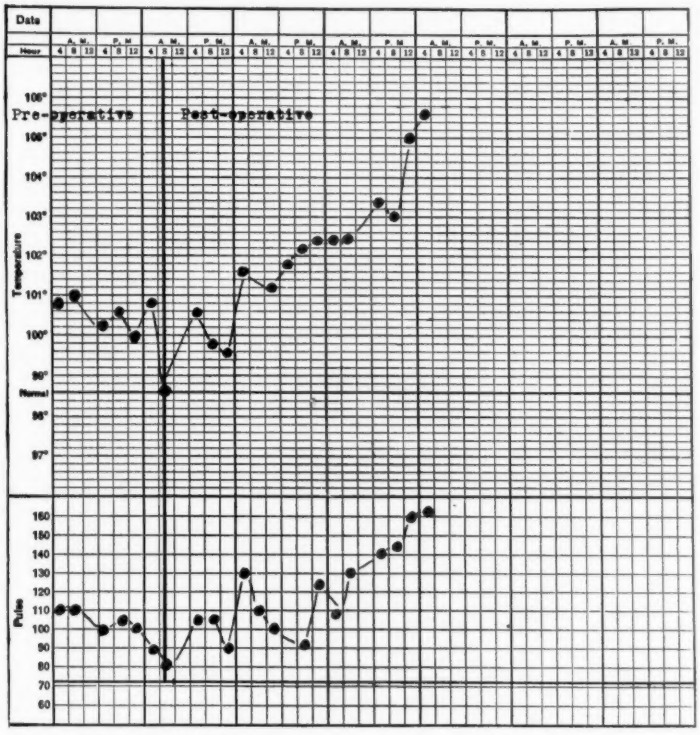
Graph 6. Effect of meddlesome postoperative management.

Using the technique required by the National Institute of Health, pigeons weighing 350 grams were injected with a lethal dose of Clostridium welchii toxin—0.013 gram and 1 cubic centimeter of perfringens antitoxin; all of the control pigeons died. One cubic centimeter of serum obtained from individuals in a normal state of health was then injected with the Clostridium welchii toxin antitoxin mixture into 28 pigeons; they all died. In another group, 1 cubic centimeter of serum obtained from patients who had recovered from simple appendicitis was injected with the Clostridium welchii toxin antitoxin mixture; 23 died and 2 lived. In another group, serum obtained from patients suffering with peritonitis due to a pelvic infection was injected into 33 pigeons; 25 died and 8 lived. Finally 63 pigeons were injected with the lethal dose of Clostridium welchii toxin antitoxin mixture and serum obtained from patients who had recovered from spreading peritonitis due to a perforated appendix; 46 per cent of them lived and 54 per cent died. Antitoxin of the Clostridium welchii was present in 75 per cent of the patients' serum—18 of 24. In addition to these tests, convalescent lyophilized serums that had been removed from man and dogs and had been standing at room temperature for 465 days, were injected into pigeons and found to contain antitoxin of the Clostridium welchii.

GROUP III—POSTOPERATIVE-INDUCED SPREADING PERITONITIS

In another communication the senior author has emphasized the importance of "Management of Spreading Peritonitis Due to a Perforated Appendix" (6). A disease with a recognized mortality of from 27 to 45 per cent can be successfully treated only by those who have previously managed similar cases. From the time of admission until the patient has successfully overcome the usual maximum dose of toxins, conferences should be held between surgeon-in-chief, associates, and surgical residents. Had this been done routinely, on the services on which the following patients were treated, catastrophes would not have occurred.

The following abstract with graphic illustration (Graph 5) shows what may happen when drains are removed too early.



Graph 7. Effect of use of peristaltic stimulants after operation.

Male, aged 15 years, had symptoms and signs of spreading peritonitis following a perforated appendix. Castor oil was given immediately after onset of symptoms. Nitrous oxide-ether anesthesia was used. Through a transverse incision, the appendix was removed, and saline and glucose were given after operation. No perfringens antitoxin was given. Drains were removed at the end of 24 and 48 hours, respectively.

Four doses of antigen were given as well as a laxative before operation. Appendix was removed at operation, the drains were removed 24 hours and 48 hours after operation.

Meddlesome postoperative management is shown in this abstract and Graph 6.

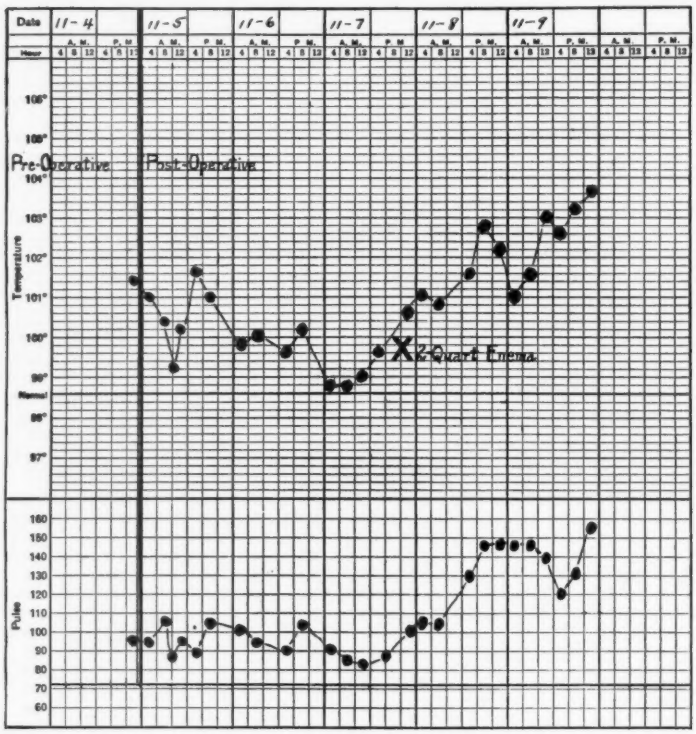
Female, aged 21 years, had symptoms and signs typical of spreading peritonitis complicating acute perforative appendicitis. *Physician prescribed* laxative immediately after onset of pain. Operation was performed 45 hours after the onset of symptoms. Spinal anesthesia, neocaine, was used. A transverse incision was made, and the appendix removed. Twelve hours after operation 1 cubic centimeter bacteriophage and 100 cubic centimeters of normal saline were introduced through drainage tube into the peritoneal cavity.

Three doses of antigen, a laxative before operation, then removal of appendix at operation, and injection of bacteriophage and saline, after operation, are the factors in this case.

The postoperative use of peristaltic stimulants is shown in this abstract with Graph 7.

Female, aged 61 years, had symptoms and signs typical of a spreading peritonitis complicating acute appendicitis. Epsom salts were given immediately after onset of symptoms. The physician gave morphine before diagnosis was made. Operation was performed 92 hours after onset of symptoms. The anesthetic, neocaine, spinal. A transverse incision was used and the appendix removed. Immediately after operation patient was given fluids by mouth and 3 doses of pitressin.

In this case, 4 doses of antigen were given, a laxative given before operation, then the appendix was removed, and water and pitressin were given after operation. This death cannot be attributed to pitressin alone, but it is difficult to grasp the logic



Graph 8. Effect of enema after operation.

of stimulating peristalsis, thereby increasing absorption when nature is attempting to prevent absorption by diminishing peristalsis in every possible manner.

Enemas and postoperative management are noteworthy in this case (Graph 8):

Male, aged 25 years, was admitted to the hospital with a diagnosis of acute fulminating appendicitis. Epsom salts were given 30 hours after the onset of pain. Operation was done 54 hours after onset of symptoms; anesthetic, neocaine, spinal. A right rectus incision was used and a perforated appendix with spreading peritonitis was encountered. The appendix was not removed; drainage instituted. Patient was given glucose intravenously and 80 cubic centimeters of perfringens antitoxin. Inspection of Graph 8 shows a favorable reaction until the nurse, by mistake, gave him a 2-quart enema—the recurring spreading peritonitis caused his death 96 hours after operation. At autopsy the odor of asafetida was still present in the peritoneal cavity.

Ten years after this patient's operation and death, we were informed by an associate of what actually caused the death. The enema was ordered by the resident physician for a patient in an adjoining bed. The associate, then a resident in the hospital, performed the autopsy.

SUMMARY

1. Of any 100 patients who die from acute appendicitis and its complications, according to the "cause of death" on the patient's clinical records, 81 per cent die of spreading peritonitis; over 10 per cent of local peritonitis, and 7.9 per cent of other causes.

2. An accurate analysis of the group "local peritonitis" shows that a number "larger than would be considered moderate" by the average surgeon, dies, not from local peritonitis but from an operative-induced spreading peritonitis. The cause of death in this group is the failure to diagnose the "localizing process" before and to recognize it at operation. Notes on its recognition before and at operation, of the value of spinal anesthesia

and the advantages of preperitoneal palpation are appended.

3. Laxative-induced spreading peritonitis is described; colored photographs of the peritoneal cavity of living dogs contrasting the gross changes accompanying non-laxative and laxative induced spreading peritonitis are shown.

4. The part radical surgery plays in the high mortality, especially the search for and the removal of the appendix in the presence of a spreading or a localizing process before local and general immunity have developed, is emphasized.

5. Brief abstracts of case histories showing how localizing or localized processes in postoperative induced spreading peritonitis were converted into spreading processes with fatal terminations because of errors in management committed during the immediate postoperative period, are reported.

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ACUTE APPENDICITIS IN CHILDREN

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ALTHOUGH the diagnosis and treatment of acute appendicitis have been standardized to a degree, further improvement in the handling of cases must be attained if the mortality is to be still further reduced. Whether or not the mortality of acute appendicitis has been rising during the past decade, papers by Walker, Fitz, Bower, and others clearly show that the treatment of this disease has not been perfected. Certainly no one is justified in assuming a smug attitude of contentment in view of present mortality figures.

The most important factor in acute appendicitis in children is the rapidity with which the disease progresses. It is not uncommon to find a perforated appendix in a child who has been ill less than 12 hours. Advanced disease is encountered early most frequently in the two extremes of life. In a series of 100 cases in adults over 40 years of age reported by Maes, Boyce, and McFetridge, 77 per cent had gangrene, perforation, abscess formation, peritonitis, or a combination of these complications. The mortality for the series was 21 per cent. The same authors report a series of 250 children with similar complications in 73 per cent; the mortality of this series was 7.6 per cent. Hudson, quoting the State of Massachusetts vital statistics, reports that appendicitis ranks eighth in importance among all causes of death for children between the ages of 1 and 9. In children the appendiceal structures are delicate and contain a large amount of lymphoid tissue. Also the great omentum is less developed, shorter, smaller, and hence less efficient as a localizing and protective agent than it is in adults. In our own cases the omentum seldom aided in localizing the infection, and then only in a few patients over 10 years of age.

In this paper we are reporting a study of 235 consecutive cases of acute appendicitis in children 14 years of age and under. The criterion used in the final diagnosis in these cases was the composite picture made by the history, physical examination, blood count, operative findings, and the pathological report. All borderline cases were listed as chronic and excluded from the series. All patients were operated upon.

The fact that procrastination on the part of parents and physicians, as well as the giving of cathartics, raises the incidence of perforation and the mortality of this disease is well proved and ably discussed by other writers. We feel no need of going over this well known ground. Rather we wish to present this series from the viewpoint of what is to be done for a child with acute appendicitis when the patient enters a hospital. The series is presented also for the purpose of comparing procedures and results with those of other clinics, in the hope that by joining forces a general advance may be made against the disease.

Stone states that the general picture of appendicitis in children is similar to that in adults, except that the mortality in children with peritonitis is higher: 34 per cent as compared with 16 per cent in adults in his series. We agree that a similarity exists and we believe that the same criteria in history and physical examination should be used. Difficulties in diagnosis are three-fold and are found most often in the young children, from whom it is difficult to obtain a history; in whom examination must often be made without the patient's co-operation; and in whom the laboratory findings may be misleading. White cells in the urine do not rule out acute appendicitis; in fact they frequently accompany an inflamed pelvic or retrocolic appendix. Moreover, a greater number of atypical cases are found in children than in adults.

There are some definite aids to diagnosis, however, which should always be employed. The rectal examination is even more valuable in children than in adults because of the relatively greater distance the finger can reach. No examination is complete in the child un-

From the service of Dr. Damon B. Pfeiffer, Children's Hospital of the Mary J. Drexel Home.

less a rectal examination has been done. Acute appendicitis is often seen in nearly an epidemic form. Evans showed that after an epidemic of acute upper respiratory infection a wave of appendicitis will follow, the average interval in a given case being 16 days, the extremes being 1 to 60 days. Stone finds his greatest frequency of acute appendicitis in children when gastro-intestinal upsets are most frequent. Our experience corroborates that of both these authors. It is our belief that appendicitis which follows a gastro-enteritis is not only difficult to diagnose, but it is often of the rapidly progressive fulminating type.

OPERATIVE PROCEDURES

In practically every paper on appendicitis the mortality in unruptured cases is very satisfactory. The patients with perforations are the ones likely to die; therefore the skillful care of such patients is one very fruitful method of lowering the mortality of appendicitis in children. Table I is a comparison of the mortality of perforation cases in the first 3 and the last 4 years of this series. The reason for this division is that the two periods offer a contrast in operative technique, fluid administration, and postoperative care, which we believe accounts for the difference in mortality rates. In the entire series the mortality in perforation cases was reduced from 16.3 to 6.5 per cent, while the percentage of perforation cases remained unchanged. In children under 6 the mortality fell from 33.3 to 17.6 per cent. This mortality figure of 17.6 per cent was obtained in the face of a greatly increased number of perforations: 85 per cent, as compared with 46.2 per cent for the first period.

The increasing use of the McBurney incision is one of the reasons, we believe, for this lowering of mortality.

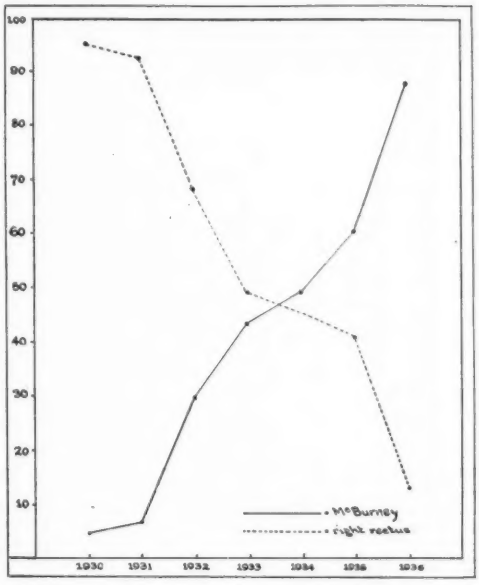


Chart 1. Showing increasing use of the McBurney incision in this series, from 5 per cent in 1930 to 87 per cent in 1936.

Chart 1 shows the relative frequency of McBurney and right rectus incisions from year to year. There are four distinct advantages of the McBurney incision over the right rectus. It permits easy, direct access to the site of disease, minimizing any soiling of uninvolved peritoneum. Drains, when necessary, can be placed laterally. A McBurney incision can be closed loosely without great risk of postoperative hernia, and such closure is very important in the peritonitis cases. In drainage cases when the McBurney incision is employed only the peritoneum need be sutured. Postoperative wound complications, such as sloughing, infection or cellulitis of

TABLE I.—MORTALITY IN PERFORATION CASES

Period	Entire series				Ages 1–5 inclusive			
	No. cases	% Perforation	Deaths	% Mortality	No. cases	% Perforations	Deaths	% Mortality
1930–1932	43	38.7	7	16.3	6	46.2	2	33.3
1933–1936	46	37.1	3	6.5	17	85.0	3	17.6
1930–1936	89	37.9	10	11.2	23	69.6	5	21.7

The figures in the percentage columns show the proportion of perforation cases in the series during the various time periods.

the abdominal wall are rarely seen. Lastly, when a secondary operation for obstruction is necessary, it can be easily performed by the right rectus route through uncontaminated structures if the primary operation was performed by the McBurney approach. For these reasons the McBurney incision is used almost exclusively.

The appendix should always be removed. The only cases in which this rule is not followed are those in the localized abscess group. Merely to drain in cases of appendiceal peritonitis is not logical; for what will prevent the continued pouring out of septic and fecal material from the diseased organ into the free peritoneal cavity? There is only one case in this series in which the appendix was not removed in the presence of peritonitis; this patient died, as is usually the case.

Drainage is used only when gross septic or fecal soiling is present or when exudate exists on the cecum, terminal ileum, or parietal peritoneum. The presence of fluid, even cloudy fluid, is no indication for drainage. When drains are used, they are used freely. A soft rubber tube is placed in the pelvis. One or two cigarette drains are placed below or lateral to the cecum. We believe that drains placed medially to the cecum increase the possibility of obstruction. Postoperative obstruction may occur in spite of placing the drains laterally, but then it is probably due to the terminal ileum falling against and adhering to the appendiceal bed. This complication can be minimized by placing a rubber sheet in the form of a cofferdam between the terminal ileum and the raw appendiceal bed. Usually it is necessary to pack a little gauze loosely in the cofferdam, care being taken to avoid contact between the gauze and the serosal surfaces. The cofferdam may be dispensed with in those cases in which all raw surfaces can be satisfactorily covered by omentum. On about the fourth postoperative day the drains should be loosened by twisting them. Depending upon the amount of drainage, cigarette drains may be removed by the fifth or sixth day. When three have been used, it is best not to remove more than one or two on a given day. When the cofferdam technique is used, the gauze packing is removed on the sixth or seventh day. The rubber dam is not removed before the ninth or tenth day. The rubber tube is the most important drain of all and is removed last. This is done by shortening it a few centimeters on consecutive days, starting at about the sixth day. It usually comes out between the ninth and twelfth days. We cannot agree with Shipley's statement that drainage can be dispensed with in early peritonitis. When drainage is used, the wound is closed loosely about the drains. In some of the severer cases no sutures at all were placed in muscles, fascia or skin. The McBurney incision makes this possible.

When the base of the appendix and the cecum are involved, i.e., when the appendicocecal junction is indurated or friable, cecostomy as an auxiliary procedure is of great benefit. This procedure is also indicated in peritonitis when the bowel is greatly distended, and it is far more effective than late enterostomy. The tube is placed directly through the appendiceal stump and when possible through the ileocecal valve, extending into the terminal ileum. In this series it was used in 4 cases: in 2 because the cecum was involved and closure would have been difficult; and in 2 because of peritonitis with great distention of the large bowel. In these 4 cases the catheter was removed at about the eleventh day, and all the wounds healed promptly.

Although a few operations were performed under local and spinal anesthesia, nitrous oxide induction followed by ether was the method generally used. We look forward to appraising the effect of the newer gaseous anesthetics on mortality and morbidity.

Most of the patients were operated upon immediately after admission. In a few cases operation was delayed. These children were all extremely ill. They showed generalized abdominal tenderness, moderate general rigidity, marked distention, and peristaltic sounds could not be heard. All had the typical facies of peritonitis. In these cases the Ochsner-Deaver treatment was instituted. If improvement was noted in 12 hours, the treatment was continued; if not, operation was performed. By postponing operation in these cases, we feel sure that a few were saved who would not have survived immediate operation. It must be

emphasized, however, that the cases in which delayed operation is indicated in children are relatively few. Certainly Sir James Berry, who in his address "The Fallen Idols" pleads categorically and without qualification for delayed operation in acute appendicitis, has injured the reputation of a useful plan of therapy by advocating its application beyond its limitations.

LOCALIZED ABSCESSES

In the localized abscess group there is no need for urgency; most patients respond better if treated for a day or two by the delayed method. When the abscess is palpable and the mass is lateral, the extraperitoneal approach is ideal, the incision being carried to the outer side of the mass, the aponeurosis of the external oblique being divided and the internal oblique and the transversalis being cut across in the line of the incision. The transversalis fascia and preperitoneal fat, which frequently are infected, are separated from the peritoneum. The peritoneum is then opened and, if the abscess is well to the outer side, one opens directly into the abscess without encroaching upon the free peritoneal cavity. The appendix should not be removed unless it is accessible and appendectomy can be accomplished without danger of contaminating the uninvolved peritoneal cavity. When the mass is not lateral or when for one reason or another it is not feasible to use the extraperitoneal approach, the incision should be made over the presenting mass. When arranging the drainage it is a help to place a cofferdam or Penrose drains in the appendiceal bed in such a manner as to keep the terminal ileum from contacting this area. This we believe will help to prevent postoperative obstruction.

POSTOPERATIVE TREATMENT AND FLUID THERAPY

The vitality of cells depends largely upon the integrity of their surrounding medium. The preservation or restoration of normal cellular environment is the sole purpose of fluid administration and represents the basic principle of fluid therapy.

The fluids we are interested in are the extracellular fluids, namely the blood plasma and the interstitial fluid. The latter, which constitutes about 20 to 27 per cent of adult body weight, is the great reservoir of the body which bathes all tissue cells. Across it food is brought to the cells and wastes are carried away. Interstitial fluid and blood plasma may be regarded as media composed of three interdependent units: water, sodium, and chloride. Sodium and chloride are known as the major extracellular ions. When waste changes affect the extracellular fluids, sodium and chloride ions are simultaneously retained or lost, but not necessarily in equal amounts.

At present, clinical tests frequently used are the plasma chloride concentration and the carbon dioxide combining power of the plasma. They measure the concentration of chloride and alkali reserve in plasma, and reflect the concentration of these substances in interstitial fluid.

The safety mechanisms of the body which insure stability of cellular fluid environment depend largely upon kidney function. The kidneys excrete excess water with dissolved waste products. When the fluid intake is low, the kidneys excrete a smaller more concentrated quantity of urine. The interstitial fluid reservoir can shrink or expand in accordance with body needs. The hydrogen-ion concentration of the extracellular fluids is stabilized because they are buffered solutions, and their osmotic pressure remains practically constant due to the interdependence of solvents and solute.

However, there are limits beyond which the stabilizing mechanisms cannot go, and in children with appendicitis, especially the late perforation cases, those limits have frequently been passed. One of the first symptoms of a sick child is its refusal to take solid food. Soon liquids too are refused. The small fluid volume intake results in dehydration. The small caloric intake makes the child dependent upon its own tissue stores of glycogen (body carbohydrate), fat, and protein for maintenance of metabolism. Children, because of their higher metabolic rates, exert a greater demand on such stores than adults, and consequently the complications of depletion occur earlier in childhood. Fats are dependent upon carbohydrates for complete oxidation. In periods of starvation, glycogen is depleted before fat, and the fat must then be oxidized alone. Such

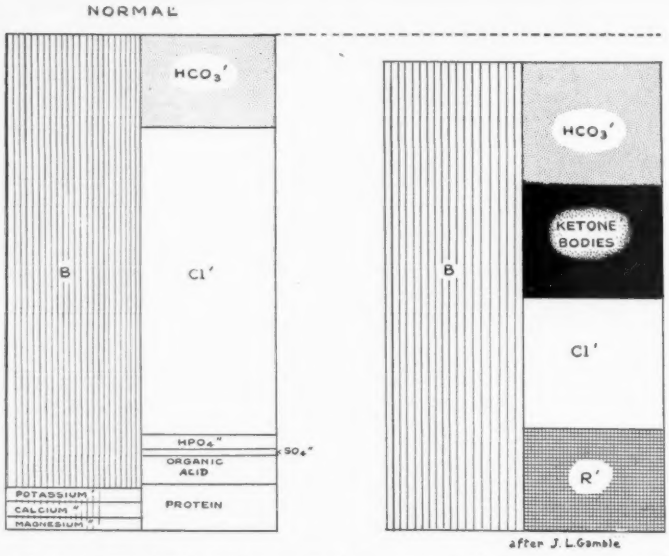


Chart 2. The double column on the left represents plasma concentration of base and acid ions in a normal individual. The second double column represents the case of a child who was vomiting because of upper intestinal obstruction. The situation is qualitatively analogous to the sequence of events in severe acute appendicitis. (Case 2 of this section.)

oxidation is incomplete, leaving the so called ketone bodies (acetone, diacetic acid, and beta hydroxy-butyric acid) as useless end products which cannot be oxidized alone and must be excreted in the urine. Worse still, ketone bodies can be excreted only in the presence of base. This leads to acidosis of starvation.

Transposing the processes into a clinical picture, we see a child who has been too ill to eat or drink for 12 or more hours. The skin and tongue reflect dehydration. The urine contains acetone. When the blood count is taken, the hemoglobin and red cells are increased, again indicating dehydration which is further corroborated by decreased urinary volume of high specific gravity. At this stage an infusion of normal salt solution with glucose will reestablish equilibrium. Glucose must be given in order to oxidize fat and ketone bodies, thus clearing the urine of acetone. Part of the salt solution replenishes the depleted body fluid reservoir. The kidneys conserve base by retaining the sodium component until the base which was lost in the excretion of ketones is replenished.

The next step in the breakdown of body balances comes with the symptom of vomiting. Since vomitus contains so much gastric juice, chlorides as well as fluid are lost to the body. Ketosis and acidosis of starvation are present. Continued vomiting brings about great chloride depletion. The continued loss of chlorides changes the picture from acidosis, dehydration, and ketosis to *alkalosis*, dehydration, and ketosis. Gamble calls this condition alkalosis and ketosis. It is also called hypochloremia. Clinically the outstanding consideration is the presence of acetone in the urine of a dehydrated patient who is not diabetic, not in acidosis, but really in alkalosis.

Chart 2 will make these relationships clear; it is taken from Gamble and illustrates the changes discussed.

We wish to state that in this discussion we are not necessarily charting a type case of appendicitis. Rather the symptoms are taken up in an order which facilitates explanation of fluid-electrolyte changes.

Once the underlying physiology is understood, estimation of the type and quantity of

fluids to be given may be discussed. In balancing the daily intake and output, fluid losses as perspiration, hemorrhage, vomitus, and drainage must be replaced by salt solution. Blood loss is obviously best replaced by blood. Fluid loss in the urine and by vaporization (exhaled air and insensible perspiration) should be replaced by distilled water. The work of Coller and Maddock in fluid balance well illustrates this. They estimate the average fluid loss by vaporization in an adult as 2,000 cubic centimeters per 24 hours. They believe an adult should excrete from 1,000 to 1,500 cubic centimeters of urine per day, preferably the latter amount; and never less than 600 cubic centimeters. The minimum daily intake for an adult is therefore 3,500 cubic centimeters and to it they add additional quantities to cover amounts lost by vomiting, drainage, hemorrhage, etc. In children the problem is more difficult. A child's surface area is larger in proportion to its weight than an adult's and for this reason children lose proportionately more fluid by vaporization. Twenty-four hour urine specimens are difficult and often impossible to collect from children. The drawing of blood for blood chemistry determinations cannot be done frequently in infants. Moreover, a child can easily be overwhelmed—drowned—by well meant but too zealous administration of parenteral fluids.

A calculation of fluid requirements for each case must first be made. In older children this must be deduced from adult requirements. In infants, formula techniques can sometimes be used. The situation is admittedly unsatisfactory and it will remain so until values for children can be established. Careful clinical observations combined with simple laboratory tests frequently repeated must check the use of fluids throughout their administration. Optimally, the tongue should be moist and skin turgor should be preserved. The optimum urine specific gravity is in the neighborhood of 1.015; acetone and sugar should not appear. A suppression of urine frequently indicates chloride edema. In such a situation glucose and distilled water are needed to preserve kidney flow. Salt solution is not diuretic and tends to be retained if excess water is not given to facilitate the selective excretion of superfluous ions. Blood chemistry determinations in children must be regarded as occasionally used procedures, very valuable, but hardly feasible as a daily routine.

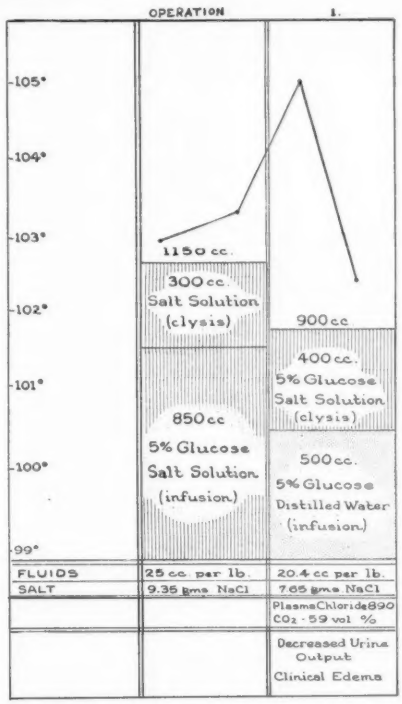


Chart 3. Case illustrating rapid development of chloride edema. This chart represents successive days in the hospital. The amounts and types of fluid are indicated. A temperature chart is superimposed.

Case illustrations will make these points clearer. Chart 3 illustrates the case of a well nourished 5½ year old girl who weighed 44 pounds.

She had been ill 11 hours, but had not vomited. Clinically there were no signs of dehydration. The urine specific gravity was 1.026, but no acetone was present. A diagnosis of acute appendicitis with perforation was made, and at operation a gangrenous perforated appendix was removed. The chart shows the amount and type of fluids given. On the second day edema and suppression of urine occurred. Blood chemistry determinations revealed a blood chloride of 890 milligrams per 100 cubic centimeters and a carbon dioxide combining power of 59 volumes per cent. Obviously the edema was caused by the administration of too much salt solution. When the infusion fluid was changed to 5 per cent glucose in

TABLE II.—ESTIMATED REQUIREMENTS

Age, 20 months; weight, 24 pounds; height, 28 inches.
Fluids: 60 c.cm. per lb. per 24 hrs.—1,440 c.cm. per 24 hrs.
Energy: 25 calories per lb. per 24 hrs.—600 calories per 24 hrs.
Salt: Probable average minimum: 0.4–0.6 gm. per day
Average intake: 1.5–2.5 gm. per day
Maximum amount tolerated: greatly above average intake. Determined by excretory ability of kidneys.

distilled water, urine output was re-established and edema disappeared. The 5 per cent glucose in water solution is practically isotonic and is the proper solution for use when water is needed and electrolytes are not depleted.

This case illustrates the effect of overzealous administration of salt solution to a child who, though slightly dehydrated, was not in electrolytic imbalance.

Another instructive case is that of a child 20 months old.

A 36 hour history revealed principally listlessness, refusal of food, purgation, vomiting, and abdominal swelling. The salient point on physical examination was a huge, symmetrically distended, tender and silent abdomen. The tongue was dry, the skin was wrinkled. Pulse, respirations, and temperature were all elevated. The specific gravity of the urine was 1.019 and acetone was present. Clearly this was a typical case of dehydration, ketosis, and hypochloremia. A hemoglobin of 40 indicated marked anemia. The intra-abdominal complaint was first diagnosed as intestinal obstruction and operation was decided upon with the intention of exposing the cecum, possibly doing a cecostomy, and at any event examining the appendix. At operation under local anesthesia, through a McBurney incision, a perforated appendix with peritonitis and paralytic ileus was found. The appendix was removed and drainage instituted. The drainage consisted of a rubber tube in the pelvis, a cigarette drain at the appendiceal site, and a cigarette drain in the lateral paracolic groove. The problem of postoperative treatment then arose. The requirements of the child, who weighed 24 pounds, were calculated on a formula basis and are expressed in Table II.

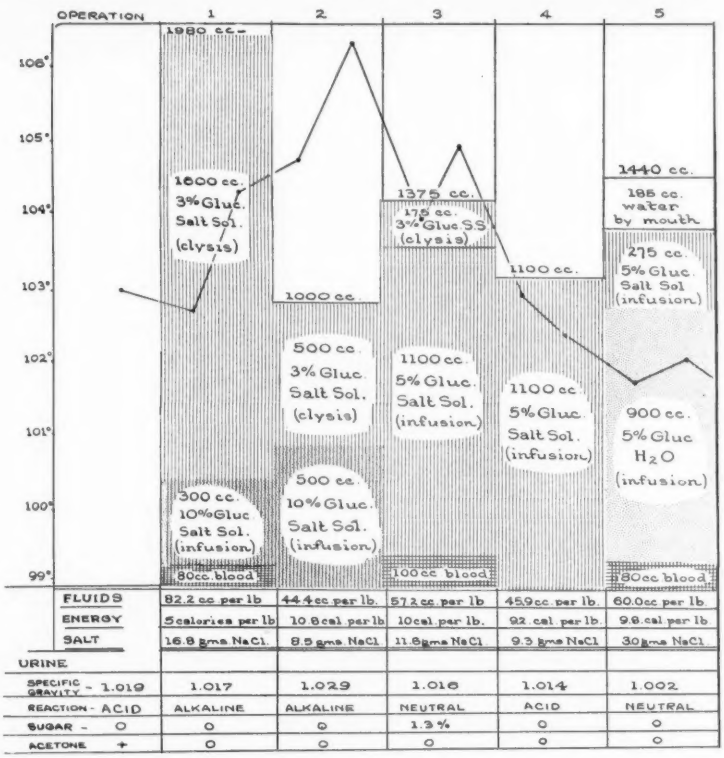
The progress of the case is shown in Chart 4. The first column represents fluids given on the day of operation, as well as on the first postoperative day. The urine analyses are instructive: acetone vanished, indicating that the administered glucose was effective; no sugar appeared, showing that administered glucose was being utilized; the reaction changed from acid to alkaline, probably indicating that base had been replenished within the body and the kidneys were excreting the administered sodium but retaining chloride. On the third postoperative day sugar appeared in the urine, and therefore the glucose content of the infusion solution was changed from 10 per cent to 5 per cent. Thereafter the urine was sugar free. Slight puffiness of the face and decreased urine output occurred toward the end of the fourth day. Therefore the infusion solution was changed to 5 per cent glucose in water. Puffiness did not progress and the extremely low urine specific gravity of 1.002 indicated that the volume of body fluids had been more than restored. On this day, too, water was first given by mouth and tolerated. Parenteral fluids were therefore discontinued. Undoubtedly chloride edema was imminent on the fourth day, but this could not be determined chemically because the child's only available vein carried the infusion cannula.

The case serves as an illustration of the amount of water and salt a depleted organism may require. It also illustrates how simple observations can reveal internal changes and how therapy can, if necessary, be guided in the absence of complete laboratory data.

The edema which occurred in the first patient and was incipient in the second is the so called chloride edema. The mechanism seems to be a piling up of water, chloride and sodium (pre-renal deviation) in the interstitial tissues when superfluous amounts of salt solution are administered parenterally. If plasma proteins are depleted by blood loss, wound drainage, or previous undernutrition, chloride edema will occur more readily. Profuse drainage undoubtedly plays an important rôle in depleting plasma proteins in these cases.

Patients with peritonitis are routinely given a small transfusion every other day until parenteral fluids are discontinued. In the second case 80 to 100 cubic centimeters were given each time. In larger children 150 to 300 cubic centimeters are given. The value of transfusions lies, we believe, in the support they give to the blood proteins and the immune bodies as well as to the red cells.

Distention as a complication in the postoperative course deserves special mention. Not only does a distended abdomen splint the diaphragms and increase the risk of pulmonary complications, but Herrin and Meek have conclusively shown that when the bowel is distended, fluid is actually secreted into the lumen. Such fluid is lost to the body until relief of distention permits reabsorption. Heat applied intermittently to the abdomen, glycerine and water enemas, and the rectal tube are



	FLUIDS	82.2 cc per lb	44.4cc per lb.	57.2 cc per lb	45.9cc per lb.	60.0cc per lb.
	ENERGY	5calories per lb	10.8cal per lb	10cal per lb.	92 cal per lb.	9.8.cal per lb
	SALT	16.8 gms NaCl	8.5 gms NaCl	11.8gms NaCl	9.3 gms NaCl	30gms NaCl
URINE						
SPECIFIC GRAVITY - 1.019		1.017	1.029	1.016	1.014	1.002
REACTION - ACID		ALKALINE	ALKALINE	NEUTRAL	ACID	NEUTRAL
SUGAR - O		O	O	1.3%	O	O
ACETONE +		O	O	O	O	O

Chart 4. This chart represents successive days in the hospital. The amounts and types of fluid are indicated. A temperature chart is superimposed.

sometimes sufficient to control distention. When they are not adequate, the Wangensteen suction apparatus and repeated small doses of pitressin practically always bring relief. We believe that the relief of distention far outweighs the possibility of spreading a peritonitis by stimulation of bowel contractions.

In the suppurative and peritonitis cases the presence of nausea, vomiting, and distention calls for the use of gastric lavage, preferably by means of the Wangensteen suction apparatus. In the peritonitis cases this procedure is used routinely, both before and after operation. Fluid requirements are estimated. When the daily intake and output are balanced, fluid losses by perspiration, vomitus, Wangensteen drainage, and other drainage must be replaced by salt solution. Blood loss is obviously best replaced by blood. Fluid loss in urine and by vaporization should be replaced by distilled water. Fluids are given subcutaneously or intravenously. Normal salt solution is used subcutaneously. Intravenously, 5 per cent glucose in normal salt solution is alternated with 5 per cent glucose in distilled water as calculations indicate. Half normal saline solution with 2½ per cent glucose may be used.

The preservation or restoration of normal cellular environment is the sole purpose of fluid administration. Critical clinical observation with frequent blood counts and daily urinalyses must sometimes serve as the only guides. When determinations of plasma chloride concentration and carbon dioxide combining power, together with blood urea and blood sugar values can be obtained, additional information is secured.

TABLE III.—POSTOPERATIVE COMPLICATIONS

Complication	Cases
Intestinal obstruction	4
Fecal fistula	1
Transient fecal fistula	3
Secondary abscess	2
Wound infection	6
Pneumonia	3
Bronchitis	2
Otitis media, bilateral	1
Acute tonsillitis	1
Abscess of thigh following hypodermoclysis	1

POSTOPERATIVE COMPLICATIONS

The postoperative complications in this series are shown in Table III. They are the conditions which increased morbidity and, in some cases, threatened to increase mortality. Concurrent illnesses present on admission, such as diabetes or pyelitis, are not listed. Complications which caused death are discussed in the section on mortality. Those listed here resulted in complete recovery.

Intestinal obstruction was by far the most serious postoperative complication. It occurred in 4 cases. All were of the perforated group.

CASE 1. Patient developed intestinal obstruction on the twentieth day. Obstruction was found at the terminal ileum. Ileocolostomy and an ileostomy above the anastomosis were performed. The child left the hospital 26 days after the second operation.

CASE 2. Patient developed obstruction on the twenty-ninth day. Obstruction was found at the terminal ileum, adhesions were divided, and the obstruction was relieved. The child was discharged 23 days after the second operation.

CASE 3. Patient developed obstruction on the nineteenth day, failed to respond to conservative treatment, and was operated upon the twentieth day. A loop of ileum was bound down in the pelvis, kinked, and obstructed. The loop was freed, thus relieving obstruction, but due to torn serosa and exudate in this part of the ileum, an ileo-ileostomy was performed. Patient was discharged 20 days later.

CASE 4. Patient developed obstruction on the nineteenth postoperative day. The obstruction was found due to the matting together of loops of small intestine about an abscess. The abscess was drained. Ileostomy was performed above the involved ileum. Patient was discharged 47 days after the second operation.

It is of interest to note that the primary operation in these 4 cases was performed through a McBurney incision. This, we feel, made the secondary operations less complicated; by using a right rectus incision the obstruction was approached through an uncontaminated field, free of adhesions.

Fecal fistula. Four patients developed fecal fistulas. All of these at primary operation had a ruptured appendix and required drainage.

CASE 1. Fecal drainage started on the third day after operation and ceased on the eleventh day. The entire stay in the hospital was 24 days.

CASE 2. At the primary operation the appendicocecal junction was gangrenous. A fecal fistula developed 16 days after operation, following the removal of drainage. Free drainage ceased in 14 days; intermittent drainage continued for 2 more weeks. The entire stay in the hospital was 59 days.

CASE 3. A fecal fistula developed 12 days after operation and drained for 8 days. The child was in the hospital 32 days.

CASE 4. This is the only case in the fecal fistula group which did not heal spontaneously. At primary operation the appendix was not removed. Abscesses under the liver, in the pelvis, and at the ileocecal junction were drained. A fistula appeared on the eighth day. The child had a very stormy convalescence. The fecal fistula failed to heal spontaneously. A second operation several months later revealed multiple fistulas to the cecum and terminal ileum, necessitating a resection of the cecum and terminal ileum, followed by an ileocolostomy.

Secondary abscesses. In two cases secondary abscesses developed.

CASE 1. At the primary operation a perforated appendix was removed. One cigarette drain was placed down to the appendiceal site and one rubber tube in the pelvis. The child pulled out the drains on the sixth day. A secondary pelvic abscess formed, which necessitated operation and drainage on the fifteenth day.

CASE 2. At primary operation a gangrenous appendix covered with exudate was removed. The wound was closed without drainage. Patient had a stormy postoperative period. Finally, on the thirty-fourth day after operation a huge pelvic abscess was drained by the abdominal route. The abscess extended from the pelvis up the left paracolic groove.

Wound infection. Six cases occurred. One of the 6 was a drained case in which the spread of infection necessitated the laying open of the entire wound. No other drained cases are included. Of the 5 remaining wound infections, 2 occurred after secondary operations for intestinal obstruction. Only one McBurney incision became infected.

Pneumonia. The 3 cases were all the bronchial type. One occurred on the twenty-third day, following an acute tonsillitis which first

TABLE IV.—DIVISION OF CASES IN THREE GROUPS

	Number	Percentage	Deaths	Mortality %
1. Non-perforated cases	146	62.2	0	0
2. Perforated with localized abscess	14	5.9	1	7.1
3. Perforated with peritonitis	75	31.9	9	12.0
Total	235	100.0	10	4.26

TABLE V.—CHILDREN 5 YEARS OF AGE AND UNDER

	Number	Percentage	Deaths	Mortality %
Non-perforated cases	10	30.3	0	0
Perforated with peritonitis	23	69.7	5	21.7
Perforated with localized abscess	0	0	0	0
Total	33	100.0	5	15.15

appeared on the eighteenth day. The second case was further complicated by bilateral otitis media. The patient, who was 18 months of age, and whose appendix was perforated, had a head cold when he was admitted to the hospital.

A single case of abscess following hypodermoclysis casts no reflection on a procedure which is very valuable in children.

MORTALITY

Of the 235 cases in this series 10 patients died, setting the mortality at 4.26 per cent. Eighty-nine, or 31.0 per cent of the cases, were perforated and all the deaths occurred in this group, thus giving a mortality of 11.2 per cent for all the ruptured cases. Fourteen of the latter were cases of localized abscess. One of these patients died, making the mortality for the localized abscess group 7.1 per cent. The perforated cases are not divided into subgroups of local or spreading peritonitis. It is often difficult to tell the extent of peritonitis at the operating table; this is especially true when the McBurney incision, the incision of choice at this clinic, is used. Moreover, different operators will not agree on the extent of a peritonitis. Bancroft, in a recent article, is also of this opinion. We divide our cases into 3 groups: non-perforated, perforated with localized abscess, and perforated with peritonitis (Table IV).

TABLE VI.—COMPARISON OF MORTALITY OF OTHER CLINICS

Author	Number of Cases	Perforated %	Mortality %
Maes et al.*	250	—	7.6
Stone‡	258	45	7.75
McLanahan†	179	—	3.91
Woodall*	295	—	7.45
This series‡	235	37.8	4.26

*All 12 years and under.
‡All 14 years and under.
†All 13 years and under.

TABLE VII.—COMPARISON OF MORTALITY RATES WITH OTHER CLINICS IN CHILDREN 5 YEARS OF AGE AND UNDER

Author	Number of cases	Perforated %	Mortality %
Maes et al.*	22 or 23	77.3	22.7
Leonard and Derow	23	74	8
McLanahan	27	—	22.2
Heyl	90	—	12.2
This series	33	69.6	15.15

*These cases are 9 per cent of 250.

Thirty-three of the cases were 5 years of age or younger. This group is 13.6 per cent of the entire series (Table V). The general mortality of the group is 15.15 per cent. Twenty-three, or 69.6 per cent, were perforated and 5 of these cases died, a mortality of 21.7 per cent for ruptured cases in the younger age group. No cases of localized abscess occurred in this group.

These figures are compared with mortality rates from other clinics. (Tables VI and VII).

A summary of the histories of the 10 patients who died follows and our decision as to the cause of death is noted for each (Table VIII):

CASE 1. P.S., aged 11 years. Patient had been sick 3 days and had been purged. Child was operated on 8 hours after admission, following an infusion of saline and glucose. The appendix was perforated; peritonitis was present. Operation consisted merely of drainage; the appendix not removed. The child died 48 hours after operation; cause of death, peritonitis.

CASE 2. R.H., aged 8 years. Child came to the hospital and a diagnosis of subacute appendicitis, bronchitis, and pharyngitis was made. She was operated on 10 days after admission. A diagnosis of chronic or subsiding appendicitis was then made.

TABLE VIII.—CAUSES OF DEATH

	Number
Peritonitis	5
Secondary abscess followed by peritonitis	1
Intestinal obstruction	2
Intestinal obstruction and peritonitis	1
Pneumonia	1

At operation a retrocecal appendix was found with localized abscess at the tip. The appendix was removed and drainage was instituted. Child died of peritonitis 14 days after operation, a fecal fistula having developed.

CASE 3. J.W., aged 5 years. Patient had been ill 48 hours; entered hospital with temperature of 104 degrees; pulse, 130; respirations, 40. Child was operated on immediately, and a ruptured appendix with peritonitis was found. Appendectomy and drainage were done. The child died 2 days following operation of peritonitis, due to the streptococcus.

CASE 4. L.D., aged 2 years. Child had been ill 6 days with persistent vomiting; was in hospital 10 hours before operation. Before operation patient was given an infusion. At operation a perforated appendix with peritonitis was found; appendectomy and drainage. Child died 60 hours after operation; cause of death peritonitis.

CASE 5. J.K., aged 2½ years, had been ill 48 hours. At operation a ruptured appendix with peritonitis was found. There was also a pedunculated Meckel's diverticulum, which was evidently not involved. The child died 24 hours after operation, from peritonitis. Cultures showed the colon bacillus.

CASE 6. L.W., aged 4 years, had been ill 4 days. Persistent vomiting had been present for 24 hours before admission. At operation a ruptured appendix was found, with peritonitis. A kink in the terminal ileum produced complete obstruction. Operation consisted of appendectomy and drainage and the freeing of obstruction. Child died 1 hour after operation. The cause of death was intestinal obstruction and peritonitis.

CASE 7. W.K., aged 7 years. At primary operation a ruptured appendix with peritonitis was found. Appendectomy with drainage was done. Convalescence was normal for 10 days, then intestinal obstruction developed. A second operation was done revealing obstruction in the terminal ileum, due to adhesions to the abdominal wall. The terminal ileum was beefy and dark in color. Ileocolostomy was performed. Patient died 24 hours following last operation—cause of death, intestinal obstruction.

CASE 8. A.C., aged 7 years. Child had been ill 48 hours. At operation a perforated appendix with peritonitis was found. Appendectomy and drainage were done. Convalescence was normal for 7 days, then child developed symptoms of intestinal obstruction. Patient was carried along for another 24 hours, and was then operated again. The terminal ileum was obstructed due to adhesions at the appendiceal site. The adhesions were separated and the obstruction was released. The child died 4 days following this operation—cause of death, intestinal obstruction.

CASE 9. M.B., aged 3 years. Child had been ill 4 days before operation. At operation a ruptured appendix with peritonitis was found. Child had a normal convalescence for 16 days after operation, then developed temperature and cough, and then bronchial pneumonia. The chest was tapped and thin pus was obtained, culture of which showed the streptococcus. The cause of death was bronchopneumonia complicated by empyema.

CASE 10. J.M., aged 4 years, had been ill 2 days At operation, a ruptured appendix with peritonitis was found. Appendectomy and drainage were done. Convalescence was normal until the fourteenth day, when child developed fever and distention. Three days later the child was again operated upon. A localized collection of pus was found in the pelvis. There was pelvic peritonitis, but no obstruction. The pelvic abscess was drained. Child died 2 days following last operation—cause of death, peritonitis.

In the first 5 cases we believe that the primary cause of death was peritonitis. Case 1 is the only one in the series in which the appendix was not removed in the presence of peritonitis. In Case 2 there was an appendiceal abscess and the appendix was removed with difficulty, which we feel was an error in operative judgment; for following the operation the child developed a typical peritonitis. In Case 5 a Meckel's diverticulum, which was not diseased, was removed. Such procedures we feel are not wise in the presence of an acute appendiceal infection.

In Case 6 there was a kinked terminal ileum with obstruction in addition to the appendiceal lesion. The child's pre-operative condition was critical and operation was finally decided upon with hesitancy. The child died 1 hour after operation. In this case nothing could have been lost by delaying operation, decompressing the intestinal tract, and administering fluids.

In Cases 7 and 8 deaths are clearly due to postoperative intestinal obstruction. The cases were operated upon a second time on the seventh and tenth days respectively, and the obstruction was found at the terminal ileum. In Case 7 an ileocolostomy was performed; in Case 8 the adhesions were simply freed.

In Case 9 convalescence was normal for 16 days, when a bronchopneumonia developed. We feel warranted in listing this as a pulmonary death.

In Case 10 a secondary pelvic abscess developed requiring a second operation and drainage. The child died of a pelvic peritonitis.

In reviewing the operative technique in these 10 fatal cases, the authors feel it is very significant that the McBurney incision was employed in only one of the cases, the right rectus being used in the others.

SUMMARY AND CONCLUSIONS

A series of 235 cases of acute appendicitis in children is presented. The series is studied from the viewpoint of what can be done for a child with acute appendicitis when patient enters a hospital. The details of pre-operative preparation, operative procedure, and postoperative care are discussed. The use of parenteral fluids is stressed as the most important part of postoperative care.

Although acute appendicitis is a common disease and its treatment is standardized to some extent, the mortality from this illness is still too high. The mortality of appendicitis is particularly high at the extremes of life.

The series of cases presented covers 7 years. The general mortality is 4.26 per cent and the mortality for children 5 years of age and younger is 15.15 per cent. The first 3 and the last 4 years of the study show clear-cut differences in operative procedures, postoperative treatment, and mortality. In the second of these two periods the mortality of acute appendicitis with perforation and peritonitis was strikingly lowered. In the entire series it fell from 16.3 per cent to 6.5 per cent. In the children under 6 years of age it fell from 33.3 per cent to 17.6 per cent.

A decrease in the use of the right rectus incision and an increase in the use of the McBurney incision paralleled the fall in mortality.

During the first 3 years of the study, fluid administration was poorly understood; but in the last 4 years, with increasing knowledge of underlying physiology, the use of parenteral fluids and their importance as an integral part of postoperative treatment was definitely established.

We believe that by continued emphasis of three cardinal points, namely, careful preoperative preparation, individualized operative technique, and skillful postoperative care, a further reduction in the mortality of acute appendicitis in children can be attained.

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INTRAVENOUS CALCIUM CHLORIDE AND ITS USE FOR THE RELIEF OF VISCERAL COLIC

A Clinical and Experimental Study

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SINCE Aub and his associates first observed that calcium chloride given by vein to patients with lead colic produced immediate relief, little has been done to emphasize the importance of this drug as an agent for the relief of spasmodic visceral pain. A search of the literature reveals that its use as an analgesic has been limited. Bauer, Salter, and Aub reported favorable results from its administration in various colics. The cramps of bile duct and ureteral obstruction and those of tuberculous enteritis and lead colic have been readily relieved by its use. The pain in these cases was thought to result from smooth muscle spasm, and the relief was attributed to smooth muscle relaxation. Calcium chloride, therefore, was credited with the property of relaxing smooth muscle.

With these facts in mind it seemed worth while to investigate further its usefulness in the relief of colic-like pain and in bladder spasm. This report is a presentation of clinical observations on the effects of intravenous calcium chloride and of experimental studies dealing with its mode of action.

PROCEDURE

The clinical value of intravenous calcium chloride was tested by administering the drug to patients suffering from severe visceral pain on the surgical and urological services of the Massachusetts General Hospital. Each patient received one or more 10 cubic centimeter doses of a sterile aqueous solution of 10 per cent calcium chloride at a rate of 1.5 to 2 cubic centimeters per minute. Since calcium chloride is irritating in extravascular tissues, care was taken to avoid subcutaneous injection. The drug produced, in all cases, a warm sensation in the mouth and often over the entire body. The intensity of this reaction was used as a guide to the rate of injection. Occasionally, if given too rapidly, nausea was experienced, and rarely vomiting followed. There was no demonstrable effect upon the heart rate. The drug is contra-indicated in patients receiving digitalis. Calcium chloride in large doses in animals produces bradycardia and finally cessation of the heart beat in systole (6, 8). This action apparently is intensified in digitalized subjects. Two fatalities have recently been reported following the intravenous administration of calcium salts in patients who were receiving digitalis (4).

Calcium chloride was given to 16 patients suffering from various kinds of spasmodic pain. Nine were completely relieved, 3 partially relieved, and 4 were not benefited. The 16 patients may be classified in 4 groups, according to the type of colic: (1) 8 patients suffering from renal colic; (2) 5 patients suffering from severe bladder spasm secondary to urethral or trigone irritation; (3) 2 patients suffering from excruciating gall-stone colic; (4) 1 patient complaining of postoperative gas pains.

EXPERIMENTAL OBSERVATIONS

In order to obtain information on the mode of action of calcium chloride, cystometric studies were made in 9 patients. Six of these had abnormal bladders from prostatic obstruction, and 3 had normal bladders. The human urinary bladder was chosen for study because it is easily adaptable to cystometry; because it is composed chiefly of smooth muscle controlled by the autonomic nervous system; and because an important part of the clinical material presented bladder symptoms. A simple water manometer connected to a fluid reservoir served as a very accurate cystometer. A standard rubber urethral catheter was used to connect the apparatus with the

From the Surgical and Urological Services of the Massachusetts General Hospital.

TABLE I.—CASES IN WHICH CALCIUM CHLORIDE WAS EFFECTIVE

Patient	Disease	Type of pain	Effect of $CaCl_2$	Remarks
F.M. 50 F 342–993	Left ureteral lithiasis	Renal colic	Immediate relief of pain	Patient awakened at 2 a.m. with severe renal colic in spite of inlying ureteral catheter. After $CaCl_2$ had immediate relief of pain and slept again. Pain did not recur
E.M. 18 F 343–810	Left hydronephrosis from aberrant vessel	Renal colic	Immediate relief of pain	Colic completely relieved until operation 2 days later, but after ¾ hrs. patient had a return of dull ache in left C.V.A. which did not require medication. At operation hydronephrosis and aberrant vessel found
M.P. 31 M E.W. 4450	Ureteral lithiasis	Renal colic	Immediate relief of pain	Patient was given ¼ gr. of morphine with partial relief ½ hr. before $CaCl_2$. Experienced complete relief for 45 min. after $CaCl_2$. A second dose 1½ hrs. later was effective for 10 min. Vomiting produced each time
W.B. 39 M E.W. 4589	Polycystic kidneys	Renal colic; left	Immediate relief of pain	Complete relief of the colic for 12 hrs. but a dull left flank pain remained. Retrograde pyelogram showed bilateral polycystic kidneys
N.O. 49 M E.W. 415	Right nephrolithiasis	Renal colic	Immediate relief of pain	Had been having constant severe colic until $CaCl_2$ was given. Definite benefit was produced for 10 min. The colic was relieved but a dull ache remained. Colic then returned and was partially relieved by morphine, gr. ¼
E.H. 64 F 343–442	Right renopelvic lithiasis	Renal colic	Immediate relief of pain	Awakened with severe colic. $CaCl_2$ produced relief of colic for 30 min. Dull ache remained. Right renopelvic lithiasis was demonstrated by x-ray and confirmed at operation
G.M. 33 M 343–159	Left nephrolithiasis	Renal colic	Immediate relief of pain	Entered having severe renal colic from a renopelvic stone. $CaCl_2$ produced immediate relief of the colic, but a dull ache persisted. The colic did not recur during the 4 days intervening before operation. Retrograde pyelogram showed stones and hydronephrosis of left kidney confirmed at operation
F.S. 65 M 342–342	Ruptured urethra	Bladder spasm	Immediate relief; complete	Patient on constant drainage for ruptured urethra. Developed severe "bladder spasm" around the catheter. Given $CaCl_2$ three times in 5 days with complete relief for 12 to 18 hrs. each time
E.I. 73 F 342–194	Carcinoma of bladder	Bladder spasm	Immediate relief; complete	Patient not on constant drainage but having severe "bladder spasm." Given $CaCl_2$ three times in 10 days with relief for 8 to 10 hrs. each time. Had previously had morphine gr. 1/6 with incomplete relief on several occasions
A.B. 79 M 342–017	Benign prostatic hypertrophy	Bladder spasm	Immediate relief; complete	Perineal prostatectomy, inlying catheter. Spasms at 15 min. intervals relieved by $CaCl_2$ for 6 hrs. Second dose 15 hrs. later had a similar effect.
A.O. 41 M 342–633	Choledocholithiasis	Biliary colic	Immediate relief	Severe frequent attacks relieved for 1½ hrs. permitting sleep after each of two doses on separate days. Common duct stones removed at operation
V.B. 44 F 351–618	Choledocholithiasis	Biliary colic	Immediate relief	Awakened by severe colic, given $CaCl_2$ with complete relief for 10 hrs. Common duct stones removed at operation

TABLE II.—CASES IN WHICH CALCIUM CHLORIDE WAS NOT EFFECTIVE

Patient	Disease	Type of pain	Effect of $CaCl_2$	Remarks
S.M. 18 F 342–628	Double right ureter and pelvis	Renal colic	No relief	Patient having attacks of typical renal colic. Pyelogram showed double right ureter and pelvis without obstruction in either. At operation there was no evidence of dilatation or infection
S.T. 65 M 342–397	Benign prostatic hypertrophy; marked cystitis	Bladder spasm	No relief	Having bladder spasms around inlying catheter. Given two doses of $CaCl_2$ without relief after either dose. Patient had a very severe cystitis
C.T. 71 M 342–287	Carcinoma of base of bladder	Bladder spasm	No relief	Patient was having severe bladder spasm. Suprapubic tube in place but no urethral catheter. The disease was extensive and there was marked cystitis. One dose of $CaCl_2$ was ineffective
H.S. 19 M 353–502	Acute appendicitis; postoperative	Gas pains	No relief	Patient having rather marked gas pains on second postoperative day. Given $CaCl_2$ with no relief

bladder. A Brodie bellows which recorded on a smoked drum kymograph was attached to the open top of the manometer when permanent records were desired (9). Ten cubic centimeters of 10 per cent calcium chloride was given intravenously to each of these patients at different points along the cystometric curve.

RESULTS

In the group of cases in which calcium chloride was given therapeutically, the results were extremely gratifying and in some cases dramatic. Table I gives a summary of each case which responded favorably to the drug, and Table II lists the cases in which no benefit was

derived. The experimental findings are illustrated by Figures 1 and 2. The observations fall in groups as follows:

Group 1. Renal colic. Five of the 8 patients with renal colic were relieved of their pain for 10 to 45 minutes; 2 were relieved for 12 hours or more; and 1 received no benefit. This last case was unusual in that the pain was secondary to the congenital anomaly of double pelvis and ureter. No evidence of obstruction or inflammation was found in this patient at the time of operation.

Group 2. Bladder spasm. After intravenous calcium chloride, 3 of the 5 patients suffering from severe bladder spasm were relieved of pain for 5 to 18 hours. Repetition of the drug in each favorable case was followed by a similar beneficial effect. Two patients received no benefit. Both of these were suffering from spasm secondary to such extensive disease that relief was obtained only by repeated large doses of morphine.

Group 3. Gall-bladder colic. Two patients suffering from severe gall-stone colic were completely relieved for ½ and 10 hours, respectively, after the administration of calcium chloride. Both patients were operated upon and each was found to have common duct stones.

Group 4. Postoperative gas pains. One patient suffering from gas pains 4 days after appendectomy was given the drug without relief.

Group 5. Cystometric observations. The cystometrograms of normal and pathological bladders have been discussed in another paper (9). After the administration of calcium chloride, in no case was there any change in the shape of the cystometrogram or in the tone of the bladder. The sensations of urgency experienced as the bladder became distended were not relieved, nor were the marked rhythmic contractions observed at this point altered by the drug (Figs. 1 and 2).

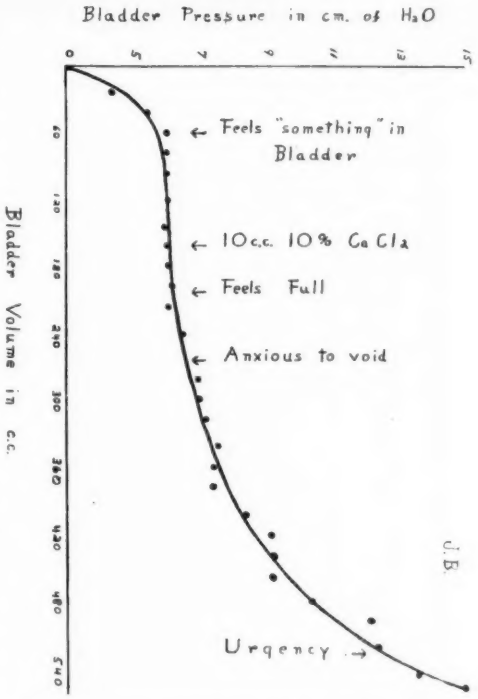

Fig. 1. Normal cystometrogram of a 50 year old man. Ten cubic centimeters of 10 per cent calcium chloride were given intravenously as indicated, with no effect upon the shape of the curve.

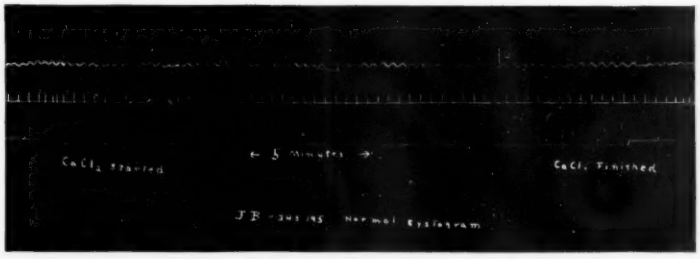

Fig. 2. A kymographic record of the same experiment showing that there is no change upon the bladder tone.

EVALUATION OF STUDY

The use of calcium chloride for the relief of colic-like visceral pain is empirical in that no satisfactory explanation for its action has been advanced. Several interesting observations, however, can be assembled and speculations offered. It was suggested and discarded by Aub and his associates that calcium chloride produced relief by relaxing smooth muscle. Their observations on the activity of obstructed intestinal loops in dogs showed that no change was produced by intravenous calcium chloride when given in twice the human dosage (5). Rozen and Perussé were unable to demonstrate definite effects on gastric contractions in dogs by oral or intravenous administration of calcium chloride or lactate. Bacq and Rosenblueth have shown that in the cat calcium chloride does not relax smooth muscle in the nictitating membrane or the non-pregnant uterus. In fact, the drug was shown to produce contraction of these structures. In the experimental observations reported herein, the discomfort induced by distention and contraction of the bladder was not relieved, nor was the tone of the bladder musculature relaxed. From this evidence it appears that calcium chloride does not bring relief of pain by producing relaxation of the smooth muscle.

The clinical cases reported here in which calcium chloride was used for the relief of pain fell into two main groups: 14 cases in which there was an irritative background and 2 with no irritative element. In the first group, symptomatic relief was produced in all but 2 cases, in both of which the disease was so extensive that only large doses of morphine afforded relief. In the second group, calcium chloride produced no relief. It appears that calcium chloride is effective in the patients with spasmodic pain resulting from a localized irritative state. Since calcium chloride does not produce relaxation of smooth muscle, it is reasonable to assume that it acts by exerting an analgesic effect upon the nervous system. Whether it interrupts afferent impulses or exerts its effect centrally is problematical.

Whatever its mode of action may be, calcium chloride is a valuable drug for the relief of spasmodic pain. It acts promptly. It is a diagnostic aid in that when the pain is relieved, the marked voluntary muscular spasm which accompanied the pain is relaxed. This permits more careful examination of the patient without the generalized sensory depression which is brought about by morphine or its derivatives.

SUMMARY

1. The effectiveness of calcium chloride in the relief of colic-like visceral pain has been demonstrated.

2. Calcium chloride is contra-indicated in digitalized patients.

3. Calcium chloride was found to have no effect on the tone or contractions of the human bladder.

4. A suggestion for its mode of action has been offered.

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THE RELATION OF SPASM OF THE SECOND PORTION OF THE DUODENUM TO BILIARY COLIC

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PREVIOUS papers by three of us (2, 3, 4, 7) and Butsch were concerned with reports showing that, in certain individuals, attacks of biliary colic following cholecystectomy were associated with contraction of the sphincter of the common bile duct which temporarily prevented bile from entering the duodenum and which resulted in elevations of pressure within the biliary system. It was shown that morphine could produce this spasm, and that in cases in which patients were suffering from the syndrome of postcholecystectomy colic its administration would result in a definite and severe attack of biliary colic.

The question that presented itself to us at that time was whether or not the spasm associated with postcholecystectomy biliary pain involved only the separate sphincter of the common duct, the existence of which was recently demonstrated embryologically by Boyden, or whether the duodenal musculature was also involved. That disturbed gastrointestinal motility is in some way involved in biliary colic has been shown by the studies of Westphal who demonstrated delayed emptying of the stomach during attacks of biliary pain. The findings to be reported here are in partial accord with Westphal's observation, and they support the theory that contraction of the duodenal musculature may play a rôle in the production of certain symptoms associated with biliary colic.

METHODS OF STUDY

Both patients suffering from repeated attacks of postcholecystectomy biliary colic and a series of normal individuals were studied.

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In each case a Sawyer tube was passed into the stomach. The patient was directed to lie on his right side, and the stomach was repeatedly lavaged with warm water in order to free it of all mucus and secretion. The tube was then allowed to pass into the duodenum; its location was verified by a free flow of clear bile, by a characteristic tugging sensation transmitted to the piston of the syringe when the tube was aspirated, and by roentgenograms. The duodenal tube was then connected to a straight, glass tube manometer containing a float for recording changes in pressure on a smoked drum (Fig. 1). The system was filled from a reservoir bottle with warm physiologic saline solution. When the reservoir was clamped off from the rest of the system, there remained a continuous column of water extending from the duodenum to the manometer. The readings of pressure thus obtained were recorded in millimeters of water.

In a few cases a rubber balloon was tied over the lower end of the duodenal tube; this was passed into the duodenum and a small amount of water was injected into it through the duodenal tube. Care was taken not to overdistend either the rubber bag or the duodenum. The end of the closed tube was then attached to the manometer for measuring changes in pressure within the duodenum. The closed system gave results identical to those obtained when the open system was used.

On several occasions in one case, two duodenal tubes were passed simultaneously. To one was attached a rubber bag, whereas the other opened freely into the duodenum. By switching the manometer from one tube to the other, without allowing the escape of fluid and therefore not altering the volume of fluid

Fig. 1. An apparatus for measuring changes in intraduodenal pressure.

within the duodenum, we were able to demonstrate clearly that the results obtained, using the open tube, were identical to those obtained when using the balloon (Fig. 2).

In some cases roentgenological studies were made by injecting a suspension of barium into the duodenum through the duodenal tube. When resistance to injection was noted, a roentgenogram was taken; when no resistance to the injection was experienced, as is usually the case with normal subjects, 40 cubic centimeters of the barium suspension were injected. Duodenal motility was observed fluoroscopically in a few cases. In other cases, patients who had had a T-tube inserted in the common duct for prolonged biliary drainage kindly consented to serve as subjects for simultaneous studies on the behavior of the sphincter and the duodenum.

RESULTS

Studies were made in three groups of cases, and 25 determinations of intraduodenal pressure were made on 17 subjects. Group 1 consisted of 6 normal individuals who served as controls. Group 2 consisted of 5 patients who had suffered from repeated attacks of postcholecystectomy biliary colic unaccompanied by jaundice, chills, or fever; in these cases attacks of pain could be induced by the subcutaneous administration of 1/6 grain (0.01 gm.) of morphine sulphate, and these attacks could then be completely and consistently relieved by the sublingual administration of 1/100 grain (0.0006 gm.) of glyceryl trinitrate. Group 3 consisted of 6 patients who had suffered unusually severe and frequent attacks of postcholecystectomy pain which had been relieved by the administration of glyceryl trinitrate only occasionally, partially, or not at all.

Group 1 (*normal persons*). The intraduodenal pressure of normal persons ranged from minus 30 millimeters of water to zero, zero being designated as the point of the manometer on a level with the xiphoid process when the patient was in the recumbent position. Tracings of the duodenal movements in such cases showed two types of wave. One type consisted of short, small waves about 1 millimeter in height, corresponding in time to respiratory movements; the second was made

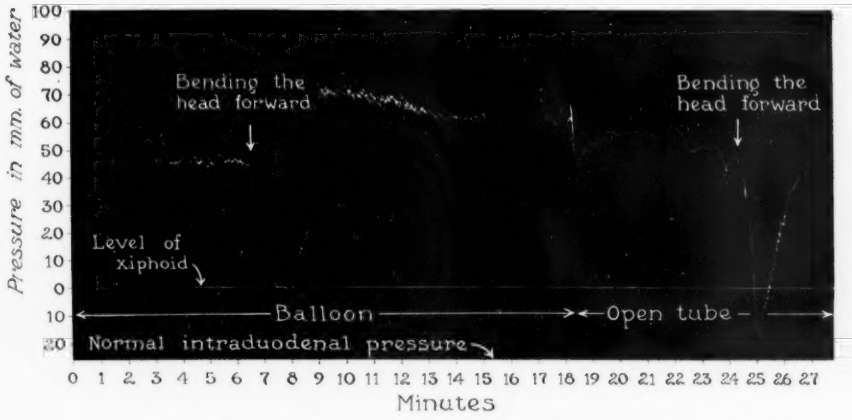


Fig. 2. Tracing showing reduction of intraduodenal pressure on bending the head acutely forward. In this case two tubes were inserted into the duodenum, one open and one with a rubber bag on the end. The pressure tracing from each is essentially the same.

up of longer waves independent of respiratory excursions. These last mentioned waves corresponded to a 5 millimeter increase in pressure and lasted from a half to two minutes. An increase in intra-abdominal pressure produced coughing or straining but increased the intraduodenal pressure to only a relatively small degree (10 mm. of water or less).

Group 2 (*patients with biliary dyskinesia*). The 5 patients in this group had suffered repeated attacks of postcholecystectomy colic; this was described as pain in the right upper quadrant of the abdomen that was projected around the right subcostal margin and into the right scapular region. As has been said, pain could be induced in these cases by morphine sulphate and relieved by nitrites. Three of these patients were studied after their common bile ducts had been drained surgically by means of T-tubes. Perfusing the common bile duct at pressures of from 50 to 200 millimeters of water produced pain described by the patient as being of the same nature as that ordinarily suffered during spontaneous colics, whereas opening the T-tube, even during the attacks of spontaneous pain, gave relief. The intraduodenal pressure in these 3 cases varied from minus 50 millimeters of water to zero (zero being at xiphoid level); the average pressure was minus 35 millimeters. In other words, the resting values for intraduodenal pressure did not differ materially from those of patients in the normal group.

These studies of intraduodenal pressure were made only during periods of freedom from pain; it seems probable that if they had been determined during attacks of pain, higher pressures would have been found. The results of studies made after the administration of morphine to a third group of patients bore out this contention.

Group 3 (*patients with intractable biliary dyskinesia*). This group comprised 6 patients who, following cholecystectomy, complained of pain confined to a point in the epigastrium just to the right of the midline; this pain was not projected, although occasionally it ran straight through to the back. Amyl nitrite did not relieve the pain in these cases. Three of these patients were studied while a T-tube was present in the common bile duct. Perfusing the common bile duct with saline solution at pressures up to 500 millimeters of water did not produce pain, although a feeling of fullness and distress was noted. The resting values for intraduodenal pressure in these cases were higher than those for either of the 2 other groups, and they ranged from 20 to 100 millimeters above the xiphoid level (that is, plus 20 to plus 100 millimeters of water, or an average of plus 58 millimeters). In 2 of these 3 cases attacks of pain developed while

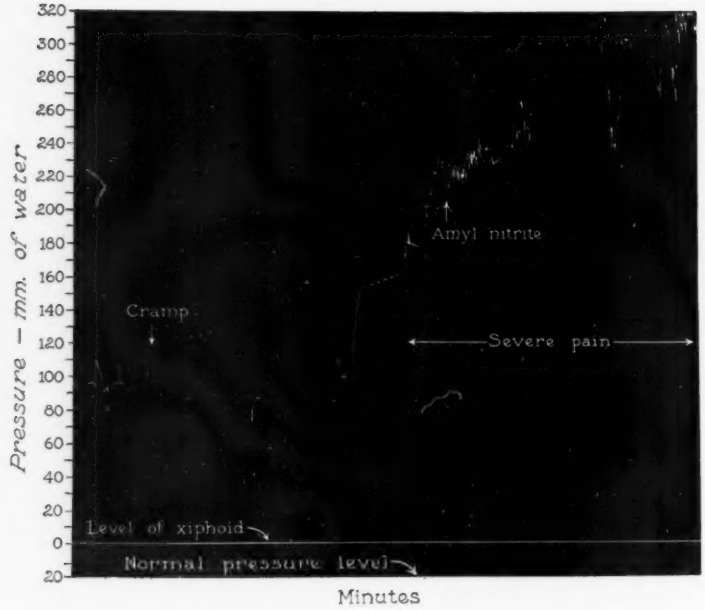


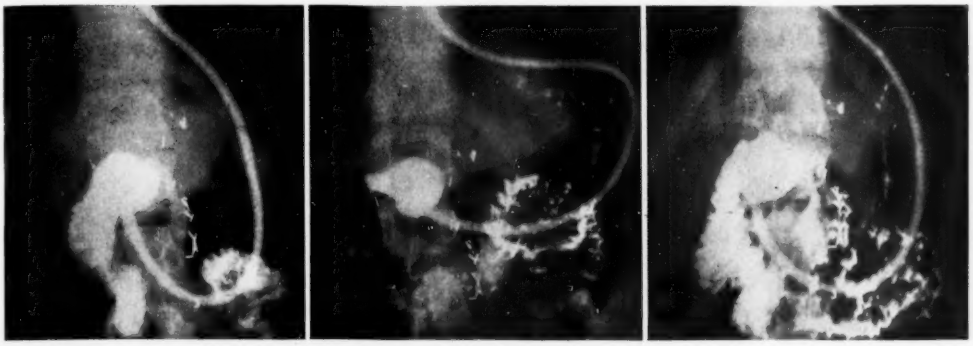
Fig. 3. Tracing obtained in a case in which the patient had a high resting value for intraduodenal pressure, showing a further increase in pressure during an attack of pain.

studies of duodenal pressure were being made; in each case the intraduodenal pressure rose above an average value of 90 millimeters to a level of 350 millimeters of water (Fig. 3). In the third case, perfusing the common duct at a pressure of 150 millimeters of water produced pain, whereas perfusing the duodenum at a pressure of 500 millimeters or more of water did not produce discomfort. In still a fourth case without a T-tube in the common duct perfusing the duodenum produced only headache.

Roentgenograms of the duodenum of 2 of these patients with abnormally high intraduodenal pressures showed the presence of some form of resistance to the flow of barium from the duodenum into the jejunum (Fig. 4, a), the barium in the third portion of the duodenum seeming to stop short at a point opposite the vertebral column. Figure 4, b also shows narrowing of the second portion of the duodenum, suggesting a moderate degree of local muscle spasm. Figure 4, c shows that this spasm can be partially relaxed by the inhalation of amyl nitrite. In this case, however, there was some evidence of constriction of the second and third portions of the duodenum even after the administration of amyl nitrite.

THE NATURE OF POSTCHOLECYSTECTOMY COLIC

The nature of postcholecystectomy colic, or if one prefers, "biliary dyskinesia," may now be considered in light of these findings. It appears that in the ordinary case in which the condition is characterized by occasional colics there is moderate sensitivity to morphine and relief from nitrites, but there is a constant change in the behavior of the duodenum, the site of the difficulty presumably being an irritable and hyperactive sphincter of Oddi. That duodenal contractions accompany prolonged spasm of the sphincter can hardly be disputed, especially in view of Westphal's observations; we had, however, no opportunity to study a patient during an attack of spontaneous pain. The important thing is that the duodenal spasm does not persist in such cases. Mor-



a b c

Fig. 4. Duodenum of a patient with a persistently high intraduodenal pressure: a, Resting state, showing obstruction in third portion and some spasm in second portion, closing it partially; b, same patient 10 minutes after administration of morphine sulphate, the second portion of the duodenum having been closed completely by more spasm; and c, same patient following inhalation of amyl nitrite; the duodenum is again relaxed, but there is a persistent narrowing in the second portion and a persistence of obstruction at the duodenojejunal junction.

phine, on the other hand, affects the duodenum of these patients, a point which will be discussed subsequently in this paper.

Patients with the severe and intractable forms of biliary dyskinesia have been shown to have a high resting value for intraduodenal pressure which is greatly increased during attacks of pain. In 1 case (Fig. 4) there was not only a high intraduodenal pressure, but a resting intrabiliary pressure in the common duct of 150 millimeters of water (the normal value being 0 to +10 mm. of water). Amyl nitrite had only a slight effect on this pressure, and an unusually large dose was required to produce even a moderate effect.

The elevated resting value for intrabiliary pressure in such cases of intractable biliary dyskinesia may be explained partly on the basis of associated duodenal spasm and partly on the basis of associated fibrosis, inflammation, or edema of the wall of the duct and of the sphincter itself. The fact that glyceryl trinitrate has given relief from pain in some cases and not in others may eventually be explained on the basis of some underlying organic change in the wall of the duct, in the sphincter, or in the duodenum in the intractable case. In 3 such cases patients have been completely relieved by placing a T-tube in the common bile duct and instituting prolonged biliary drainage. One other patient accidentally pulled out the T-tube after 5 weeks' drainage and, a few weeks later, the pain returned; at first it was mild, and then it gradually became more severe. Operation was subsequently performed, replacing the tube and complete relief was again obtained.

A duct which is dilated and thin-walled probably withstands increased pressure poorly; T-tube drainage allows a dilated common bile duct to return to its normal size. This fact was borne out in a series of studies on intrabiliary pressure made at varying periods after the insertion of a T-tube into the common bile duct. Three weeks following operation, perfusion of the common bile duct with physiologic saline solution at a pressure of 150 millimeters of water produced pain, whereas 2 months later, the patient's common duct was able to withstand pressures of 500 millimeters of water without distress. Roentgenograms made by injecting the common bile duct with brominol, according to the method of Walters and Thiessen, showed the presence of a dilated common bile duct on the earlier date and a normal sized duct 2 months later. The persistently high, resting value for intraduodenal pressure in these cases of intractable biliary dyskinesia argues for a local source of irritation which induces spasm of the duodenal musculature; this may also influence intrabiliary pressure, as will be shown later.

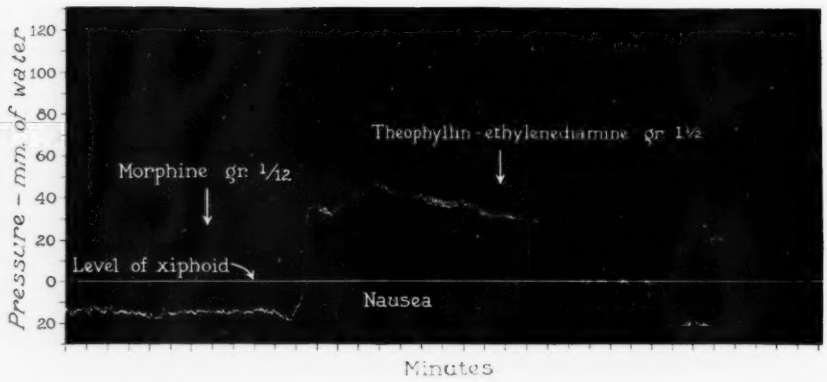


Fig. 5. Tracing of intraduodenal pressure in a normal person, showing effects of administration of morphine sulphate.

THE ACTION OF MORPHINE ON THE DUODENUM

Following the subcutaneous injection of 1/6 grain (0.01 gm.) of morphine sulphate to a mixed group of normal subjects and patients with postcholecystectomy colic the intraduodenal pressure rose in 10 cases from an average of minus 17 to plus 41 millimeters of water after a period of from 3 to 15 minutes (Fig. 5).

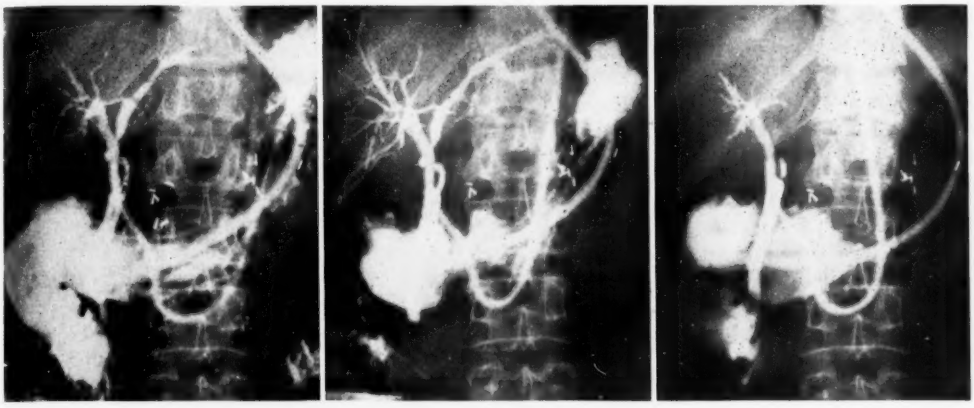
In patients with postcholecystectomy colic, roentgenological studies made 10 minutes after the injection of morphine showed spasm of the second portion of the duodenum. The outline of the first portion as well as that of the pyloric sphincter remained unchanged (Fig. 4, b). A series of roentgenograms made after simultaneously injecting the common bile duct and duodenum in one of our "intractable cases" showed that when the duodenum contracted following an injection of morphine, the lower end of the common bile duct was sharply obstructed and the opaque medium was forced up into the radicles of the biliary tree (Fig. 6). Here, the closed lower end of the common bile duct and the duodenal musculature are so intimately associated that the sphincter of the common bile duct can hardly be differentiated from that constriction produced by contraction of the muscle of the duodenal wall. The possibility that morphine acts on the duodenum and on the sphincter of Oddi simultaneously must of course be admitted. The reaction of the duodenum to morphine, so far as roentgenological and pressure changes are concerned, was essentially identical in normal subjects and in patients with occasional colic, but the reaction to morphine seemed most pronounced in patients with intractable biliary dyskinesia.

METHODS OF REDUCING DUODENAL PRESSURE

In order for an elevated pressure to exist within the duodenum, some form of resistance to the free flow of fluid in either direction must be postulated. Roentgenograms taken in cases with normal resting values for intraduodenal pressure showed that the barium tended to run freely down the bowel and up to the pyloric sphincter but that it rarely ran into the stomach; hence the resistance offered by pyloric tonus is greater than that encountered in the lower portion of the duodenum.

In other cases with high resting values for intraduodenal pressure there was roentgenological evidence which indicated some form of resistance to the flow of barium from the duodenum to the jejunum (Fig. 4, a and b).

In such cases a rapid reduction in pressure could be due either to relaxation of the duodenal musculature or to relaxation of the pylorus. The present studies do not furnish evidence which would allow for definite differentiation. We have not been able to determine whether the decreased pressure is due to relaxation of the pylorus or to a decrease in the resistance offered to the flow of fluid from the duodenum to the jejunum.



a b c

Fig. 6. Serial roentgenograms after simultaneous injection of the common bile duct with brominol through a T-tube and of the duodenum with barium: a, at rest; b, 10 minutes after administration of morphine sulphate, showing spasm of duodenum and reflux of medium into the finer radicles of the biliary tree; and c, after inhalation of amyl nitrite, showing relaxation of duodenal spasm and decrease in amount of medium in the bile ducts.

METHODS OF REDUCING INTRADUODENAL PRESSURE

Two methods of reducing intraduodenal pressure were found: (1) pressure applied to the neck in the region of the carotid sinus, and (2) moderate sized doses of insulin.

Stimulating the endings of the vagus nerve in the neck by such procedures as bending the head acutely forward, by pressure over the carotid sinuses, or by electric stimulation over the left carotid sinus, produced a marked reduction in intraduodenal pressure on 15 occasions in 5 individuals; such stimulation produced a fall of from plus 148 to plus 30 millimeters of water in 1 case. Insulin in doses of 20 to 30 units was used on 3 occasions in 1 case and on 2 occasions in another; its administration reduced an elevated intraduodenal pressure from around plus 65 to plus 10 millimeters of water. This effect began 15 minutes after the insulin was given and progressed for from 35 to 45 minutes thereafter. Pressure rose in each case following the intravenous administrations of glucose. What the significance of these findings is we do not know. Such procedures produce no result on the intraduodenal pressure of normal individuals for the obvious reason that there is no resistance to the flow of fluid at the lower end of the duodenum and the pressure is already low.

APPLICATION OF METHODS

The methods described for lowering intraduodenal pressure, namely, administering insulin and applying pressure over the carotid sinus or vagus nerve in the neck, will require further investigation to determine whether the decrease in duodenal pressure is due to relaxation of the pylorus or of the distal part of the duodenum. Schmidt and one of us (McGowan) has demonstrated a similar relaxation of the normal human cardia by means of these methods.

The duodenum of a young girl with a roentgenologically normal gall bladder was studied fluoroscopically during an attack of biliary colic. Through a Sawyer tube a suspension of barium was injected slowly into the duodenum while it was observed under the fluoroscope. Marked spasm was present in the second portion of the duodenum, similar to that represented in Figure 4, b. At intervals, a small bolus of barium, representing 3 to 5 cubic centimeters measured on the injecting syringe, would pass down through the spastic second portion of the duodenum. When it reached the point where the duodenum joined the jejunum, it would encounter an antiperistaltic wave which forced it back into the stomach. Following the inhalation of amyl nitrite this situation was entirely changed, the

whole of the duodenum filling evenly with barium. At intervals a constricting band would appear at the junction of the first and second portions of the duodenum and pass leisurely downward, pushing in front of it a generous quantity of barium over into the jejunum. Similar studies were made later on another patient, during periods of freedom from pain. There was then no evidence of spasm in the duodenum and the barium passed readily into the jejunum.

Two other patients were also studied roentgenologically. They had had persistent postcholecystectomy biliary colic, associated with repeated attacks of vomiting, existing, respectively, for 8 and 10 years. Glyceryl trinitrate relieved the pain only partially. Marked narrowing of the duodenum was found in each case. One of these patients was subsequently operated on and a tube was placed in the common bile duct for prolonged drainage. Her pain was promptly relieved but the vomiting continued for 2 weeks, subsiding only completely one month after operation. At this time roentgenograms were taken following the injection of the common bile duct with brominol and the duodenum with barium. These showed narrowing of the second portion of the duodenum. The common bile duct was dilated, and narrowed at the lower end where it joined the duodenum.

The foregoing observations, while by no means complete and therefore insufficient to warrant any sweeping conclusions, do appear to incriminate the duodenal musculature as a factor in the production of some of the symptoms of biliary colic. While the pain itself may not necessarily depend upon such a state of duodenal contraction, it is probable that the nausea, vomiting, fullness, and epigastric distress may be related to the irritable or spastic state of the duodenum. The nausea and vomiting which so often follow the administration of morphine are probably due to vigorous contractions of an already spastic musculature. Furthermore, evidence is offered to show that, in intractable biliary dyskinesia, the duodenal motility is altered sufficiently to produce of itself certain symptoms. In such cases there is some interference with normal duodenal emptying, due to an apparent contracting ring at the duodenojejunal junction. One would not be justified in assuming on the basis of the evidence presented that altered duodenal motility is a pathognomonic sign of intractable biliary dyskinesia, but it does appear that duodenal hyperirritability plays a definite rôle in the persistence of symptoms in such cases. In other words, the behavior of the duodenum deserves further study in these intractable cases, since its continued spastic state argues for a possible reflex or focal cause of organic nature. In distinction to these cases, one may cite cases of transient and easily relieved colics of simple biliary dyskinesia in which intraduodenal pressures are normal.

SUMMARY AND CONCLUSIONS

A method for studying the activities of the duodenum has been presented which consists of measuring changes in pressure in the duodenum by means of an ordinary open Sawyer duodenal tube and a water manometer. After injecting a mixture of barium and water directly into the duodenum through the tube, roentgenograms were taken of the duodenum under various phases of changes in pressure. Morphine produced an increase in intraduodenal pressure, apparently due to spasm of its second portion. Amyl nitrite relaxed this spasm. Roentgenograms taken by simultaneously injecting brominol into the common bile duct through a previously inserted T-tube, and by injecting barium into the duodenum through a Sawyer tube, showed that the spasm of the duodenum produced by morphine seems also to involve the lower end of the common bile duct.

Resting values for intraduodenal pressure were determined in 3 groups of cases. Patients suffering from repeated attacks of postcholecystectomy biliary colic capable of relief by nitrites were found to have intraduodenal pressures of from minus 35 to minus 50 millimeters of water. In normal subjects, pressures of minus 30 to 0 millimeters of water were encountered. In individuals with intractable postcholecystectomy colic, not relieved by nitrites and presenting roentgenological evidence of obstruction of the third portion of the duodenum, the resting values for intraduo-

denal pressure were between plus 30 and plus 100 millimeters of water. In patients with abnormally high intraduodenal pressures, stimulation of the carotid sinus or moderate doses of insulin produced a moderate reduction in pressure; this was of a temporary nature, however, and did not give any constant relief from pain.

The evidence presented indicates the importance of studying duodenal motility in cases of intractable biliary colic and the desirability in such cases of searching for some organic change in the common duct, sphincter, or in the duodenal wall itself.

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A NOTE ON THE RESPIRATION-LIKE MOVEMENTS OF THE HUMAN FETUS

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IT is well known that the breathing mechanism is developed before birth and that premature interruption of a pregnancy does not necessarily lead to death of the fetus for want of functional lungs. Furthermore, the fetus occasionally executes rhythmic respiratory movements spontaneously *in utero* shortly before birth. Ahlfeld (1905) published very convincing graphic records of such activities and Snyder and Rosenfeld (1937) have demonstrated them cinematographically.

Although incidental mention of respiratory-like movements of the human fetus at artificial abortion, hysterectomy, or hysterotomy has been made by a number of investigators, very few reports concern the fetus in the first half of gestation. The youngest specimens have been described by Erbkam (1837) and Minkowski (1922). The former saw a fetus of about 4 months (170 mm. crown-heel length) open its mouth as though to breathe. The latter reported deep inspiratory movements of the thorax with the mouth opening and the elevation of the arms in one of 180 millimeters crown-heel length. Strassmann (1903) expressed the opinion that the first human fetal movement is an elevation of the arms as in taking a breath but he cited no evidence for his belief. Hooker (1936) stated that respiration was about the only specific activity not represented in at least an imperfect stage at 14 weeks (121 mm. crown-heel length).

Because so little is known about early prenatal respiratory activity and because the subject is receiving attention in several experi-

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mental laboratories at the present time, it seems desirable to report observations in three new specimens smaller than any that have been described previously.

Several years ago one of us (C.A.D.) had the opportunity to observe the behavior of a 4 month old fetus of about 140 or 150 millimeters crown-heel length. Pregnancy was terminated for therapeutic reasons by dilating the cervix; the specimen with its placenta was delivered promptly. It was soon seen to be executing rhythmic movements of the head and trunk which involved contractions of the diaphragm and chest muscles. These inspiration-like activities were strong and resembled rhythmic gasping. They continued for many minutes, becoming slower after they were first noticed.

On another occasion (observed by D.E.M. and R.R.G.) a gravid uterus was obtained;[1] taken to a room adjoining the operating theater and opened approximately 3 minutes after the blood vessels had been clamped. The fetus was freed from its membranes and the umbilical cord was severed. At this time rhythmic movements of thoracic and abdominal muscles resembling rapid breathing were seen. They occurred periodically for about 3 minutes. Occasionally the fetus threw back its head as though to gasp and with this movement the costal margin was elevated. The specimen measured 70 millimeters crown-rump length, 85 millimeters crown-heel length. Eighty-four days had elapsed since the last menstruation.

Again more recently a fetus of 62 millimeters crown-rump length and 85 millimeters crown-heel length was obtained (by R.R.G.) at hysterectomy. The last menstruation had begun 84 days previously. Three distinct respiratory movements were seen in the first 3 minutes of observation. Contralateral arm reflexes followed tapping the arm, but no responses were obtained from the legs.

It is evident from these observations that the human fetus can execute rhythmic respiratory-like movements in the third and fourth months. That they do so normally *in utero* is not implied, because in every instance a state of anoxemia with carbon dioxide accumulation had been set up in the fetus by removal from the uterus. Observations in other forms of mammals and in birds (W.F.W., unpublished) indicate that such activities do not appear until late in fetal life unless the oxygen exchange mechanism is disturbed.

[1] On the service of Dr. H. O. Jones at St. Luke's Hospital, Chicago.

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THE EFFECT OF LIGHT ON BENZPYRENE CANCER IN MICE

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ALTHOUGH it has long been assumed that light is a factor in the production of skin cancer in man, until recent years little experimental evidence has been adduced to support or deny this conclusion. The study of the rôle of light in the production of carcinoma has of late received increasing attention and the problem has been approached from many angles. Some workers have merely subjected experimental animals to light from various portions of the spectrum. For example, Finlay exposed mice to the rays of a quartz mercury-vapor lamp and found that after 8 months papillomas and malignant epitheliomas appeared. Tarred animals exposed to ultraviolet light developed carcinoma in a shorter time than when either tar or violet ray exposure was used alone. Herlitz, Jundell and Wahlgren, using mice, and Putschar and Holtz, using rats, were able to produce more carcinomas in the animals exposed to ultraviolet light than in unexposed controls. On the contrary, Rathman and Bernhardt, using rabbits, were unable to produce carcinoma after repeated exposure to ultraviolet rays, and Kohn-Speyer could not produce tar tumors in mice more quickly by the additional use of ultraviolet light. Thus, this line of approach has given quite contradictory results.

Other workers have attempted an opposite approach to the problem in that they subjected experimental animals to a complete absence of light. Dodds, Bang, Lipschuetz, Schorr and Ssobolewa, Vlès, de Coulon and Ugo, and Seelig and Cooper, are among the workers who have attempted experimental studies on the effect of total darkness on the production of carcinoma. The conclusions from these studies have also been contradictory.

A third line of approach has been the study of the effect of certain so-called light sensitizing agents on experimental carcinogenesis. Various agents have been used in an attempt to produce light sensitivity in animals, the most important of which in connection with our studies are cholesterol and hematoporphyrin. Roffo and his co-workers believe that a relationship exists between the photoactivity of cholesterol and cell function, that sunlight serves to fix the cholesterol in the tissues and that cholesterol then becomes an organic accumulator of light. The cholesterol which he believes becomes photoactive as a result of oxidation by light is thought to play an important rôle in the production of carcinoma. Hausmann has perhaps done the greatest amount of work upon the use of hematoporphyrin as a light sensitizing agent. It has been found that mice injected subcutaneously with hematoporphyrin and kept in the dark show no peculiar effects of the drug; however, when these animals are exposed to light their ears, noses, and paws become markedly hyperemic and after sufficient exposures a marginal necrosis of the ears may develop. The drug also apparently produces an intense itching of the skin, for the mice scratch almost constantly during the period of exposure to light. Rothemund has also made extensive studies upon the physiological effects of hematoporphyrin and other light sensitizing substances, such as certain derivatives of cholorophyl. However, not much work has been done on the use of these chemicals with relation to carcinogenesis. Buengeler has studied the effect of the injection of various light sensitizing agents, such as eosin, anthrasol, and hematoporphyrin on the production of tar cancer in mice, and has found that these substances which increase the light sensitivity of the experimental animals seem also to increase their susceptibility to tar cancer. However, work upon this phase of the problem of the rôle of light in the production of carcinoma is still in its infancy and the results are as yet not clear cut.

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TABLE I.—AUTOPSY FINDINGS IN THE MICE KILLED AT THE END OF 26 WEEKS

Group receiving benzpyrene and exposed to light			Group receiving benzpyrene and kept in the dark		
No.	Microscopic findings upon examination of neck lesions	Other autopsy findings	No.	Microscopic findings upon examination of neck lesions	Other autopsy findings
23	Cancer	Lung tumor	28	Hyperplasia	
24	Cancer	Lung tumor	29	Cancer	Lung tumor
25	Cancer	Hepatitis	30	Cancer	Hepatitis with necrosis
26	Cancer	Lung tumor	31	Hyperplasia	
27	Hyperplasia		32	Cancer	Hepatitis
28	Cancer	Hepatitis	33	Cancer	
29	Cancer	Hepatitis	34	Cancer	
30	Cancer	Hepatitis with abscess	35	Cancer	Hepatitis
31	Cancer		36	Cancer	Hepatitis
32	Cancer		37	Cancer	Hepatitis
33	Cancer		38	Hyperplasia	
34	Cancer		39	Hyperplasia	
35	Cancer		40	Cancer	Lung tumor
36	Cancer		41	Cancer	
37	Cancer		42	Hyperplasia	Pleurisy, hepatitis
38	Cancer		43	Cancer	Lung tumor, hepatitis
39	Cancer	Liver abscess	44	Cancer	Lung tumor, hepatitis
40	Hyperplasia	Lung tumor	45	Cancer	Lung tumor, hepatitis
41	Cancer		46	Cancer	
42	Cancer		47	Cancer	Lung tumor
43	Cancer	Lung tumor	48	Hyperplasia	Lung abscess
44	Cancer	Lung tumor	49	Cancer	
45	Cancer		50	Cancer	Hepatitis
46	Cancer	Lung tumor			
47	Hyperplasia				
48	Cancer				
49	Hyperplasia	Hepatitis			
50	Hyperplasia				

Since so much confusion exists concerning the relationship between light and carcinogenesis, the present experiments were undertaken to determine: (1) the effect of repeated exposures to light from a definite source upon the production of benzpyrene carcinoma in mice, and (2) the effect of this light upon the development of benzpyrene carcinoma in mice previously made light-sensitive by repeated injections of small doses of hematoporphyrin.

MATERIALS AND METHODS

One hundred and fifty female mice were used in these experiments. The animals were obtained from the Rockland Farms, New York City, and belonged to the Rockland all purpose strain, which has been inbred for 35 generations. At the beginning of the experiment all of the animals were 3 to 4 months old. The mice were divided into three groups of 50 each. All of the groups were housed in standard metal cages, which except during the experimental procedures were kept in a compartment darkened with black paper. One drop of a 0.5 per cent solution of benzpyrene (Union Chimique Belge) in benzol was applied twice weekly to the skin on the back of the necks of all the mice for a period of 6 months. In addition, the animals in one group of 50 mice were injected subcutaneously on the rump 6 times (at 4-day intervals) with 0.5 cubic centimeter of a solution of hematoporphyrin prepared by dissolving 0.1 gram of hematoporphyrin in 2.5 cubic centimeters of tenth normal sodium hydroxide and diluting the mixture to 100 cubic centimeters with distilled water. After six injections this procedure was discontinued, because of the high mortality due to the toxicity of the hematoporphyrin. This group and a second group of 50 mice, which were simply painted with benzpyrene, were exposed for 1 hour daily for 6 months to the light from a General Electric Type S1 sun lamp, 600 glass bulb. This lamp transmits a band of rays between 2894 and 5500 Ångström units (thus including rays from the ultraviolet and from the visible spectrum). This lamp according to the General Electric Company[1] supplies approximately 10,000 "E-vitons" and takes about 7 minutes at a distance of 30 inches from the lamp to produce an immediate slight reddening of the skin in humans. The mice were exposed to the lamp in a cage measuring 20 inches in length by 20 inches in width and 6 inches in height, made of ½-inch mesh wire screen. The cage was divided by similar

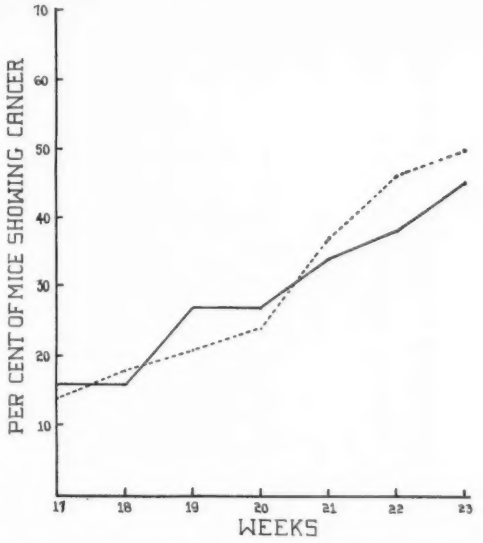
[1]We are deeply indebted to the General Electric Company for their fine co-operation in this research.

screening into 25 compartments, each measuring 4 by 4 inches. Not more than 2 mice were placed in each compartment during the period of exposure. The cage was placed upon a white enameled metal base to insure a maximum reflection of light. The center of this base was always placed 36 inches below the bulb of the lamp.

The third group of 50 mice, which were used as controls, were kept constantly in the darkened compartment.

During the 6-month experimental period, the necks of all of the mice were carefully examined once a week for gross evidence of carcinoma at the site of benzpyrene application. The thickness and hardness of the lesion, the depth and width of the infiltration, and the shape of the pearly border were noted. When the border was approximately 3 millimeters thick, when the induration was woody hard and extended over an area at least 1 centimeter in diameter, and involved the subcutaneous tissue, and when the edge of the lesion had a typical pearly appearance, a diagnosis of carcinoma was made.

The control mice, which died during the course of the experiment, were subjected to autopsies and the areas on the backs of the necks which had been treated with benzpyrene were removed for sectioning and microscopic study. Thus, a rigid control was maintained against the purely tentative clinical diagnoses of carcinoma. At the end of 6 months all the mice remaining alive were killed with ether and likewise subjected to autopsies. Microscopic sections of the lesions on their necks produced by the application of benzpyrene were also made. Sections were stained routinely with hematoxylin and eosin, and with Van Gieson's stain for connective tissue.

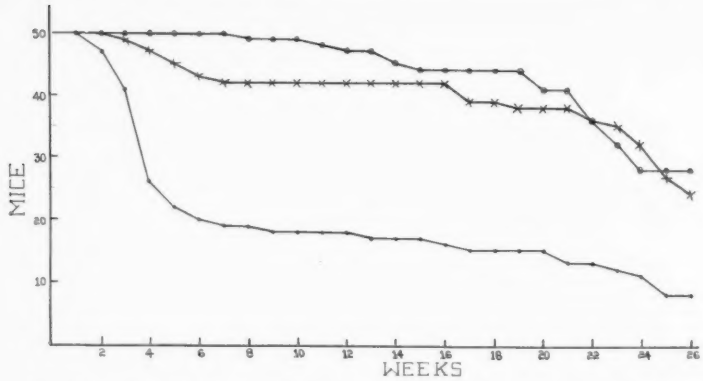


Graph 1.—Showing the percentage of mice developing carcinoma after the 17th week of the experiment.
.....Group of mice kept in the dark and painted with benzpyrene.
———Group of mice exposed to light and painted with benzpyrene.

DISCUSSION

The first definite clinical or gross evidence of carcinoma was observed in both the experimental and the control mice at the beginning of the seventeenth week of the experiment. At that time, basing our conclusions on the gross factors of thickness and hardness of the lesion, degree of infiltration, and appearance of the border, 14 per cent of the animals painted with benzpyrene and exposed daily to the sun lamp and 16 per cent of the controls which were painted with benzpyrene and kept in the dark, showed evidence of carcinoma. From that time until the end of the experiment the percentage of malignancy rose about equally in both groups until the twenty-third week, at which time 50 per cent of the experimental animals and 45 per cent of the controls had apparently developed carcinoma. A curve showing the increasing percentage of mice developing carcinoma in the two groups during the latter part of the experimental period is shown in Graph 1.

The mortality during the course of the experiment was rather high in all groups of mice. Graph 2 presents a mortality curve for all of the animals used in the experiment. Of the group of animals which were painted with benzpyrene and exposed daily to the sun lamp, 22 died before the end of the experiment. Of these 10 animals were found to have developed carcinoma (proved by microscopic section). Among the controls, which were painted with benzpyrene, but kept in the



Graph 2.—Showing the mortality rate in the three groups of mice used in the experiment.

Group exposed to light and painted with benzpyrene.

Group exposed to light, injected with hematoporphyrin and painted with benzpyrene.

Group kept in the dark and painted with benzpyrene.

dark, 26 animals died during the course of the experiment and of these, 13 developed carcinoma. Thus 45.4 per cent of the experimental animals and 50 per cent of the control animals, dying during the course of the experiment, developed carcinoma. The difference in the incidence of carcinoma in the two groups is quite insignificant.

Of the group exposed daily to the sun lamp, 28 were still alive at the end of 6 months, and of the controls 23 were living at the end of the same period. These animals were killed, autopsies were performed, and microscopic sections prepared of the areas on the neck. Twenty-three, or 82.1 per cent, of the experimental animals and 17, or 73.9 per cent, of the controls were found to have carcinoma. Table I presents an analysis of the autopsy findings in these two groups of mice. Because of the relatively small number of animals in the two groups, this difference is suggestive rather than significant.

The group of 50 mice which were given injections of hematoporphyrin, furnished very little reliable data concerning the relation of light sensitivity to the development of benzpyrene carcinoma. The hematoporphyrin proved to be highly toxic and after 6 injections the use of the drug was discontinued. The mortality in this group was very high. Twenty-one of these mice died during the first month of the experiment, the period during which hematoporphyrin was being given. The mortality rate of this group as compared with the controls is given in Graph 2. Only 4 of the mice that died during the course of the experiment developed carcinoma. At the end of 6 months when the animals remaining alive in all groups were killed and examined, only 7 of this group were still alive. Upon microscopic examination of the lesions on the necks of these animals, all but one of them were found to have carcinoma. Because of the high mortality in this group occasioned by the toxicity of the hematoporphyrin, these results are only suggestive. This study of the effect of light sensitizing substances upon benzpyrene cancer in mice is to be continued.

SUMMARY

The incidence of skin cancer in mice treated with benzpyrene was studied in a group of 50 mice exposed to a sun lamp, and contrasted with the incidence in a similar group kept in the dark.

The difference in the incidence of skin cancer in the two groups was found, in our judgment, not to be sufficiently marked to warrant drawing dogmatic conclusions.

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THE CONCENTRATION OF SERUM SULPHATE AND BLOOD UREA IN PROSTATIC HYPERTROPHY ASSOCIATED WITH URINARY OBSTRUCTION

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ORDINARY tests of renal function at times may be of limited value in the estimation of renal function in cases in which retention of urine is associated with prostatic hypertrophy. There are several reasons for this regrettable fact. A patient afflicted with an enlarged prostate gland may have kidneys which have inadequate functional ability as the result of changes secondary to a renal arteriosclerosis which existed prior to the onset of urinary obstruction, while another patient may have had sound kidneys prior to the onset of urinary obstruction but renal insufficiency may develop as a consequence of the obstruction of the urinary stream. Obviously, all possible gradations and variations between these two extremes will be found in practice. It is a well known fact that the excretion of phenolsulphonphthalein may be normal or at most slightly decreased at the onset of acute renal insufficiency which developed from urinary obstruction in a case in which a patient had sound kidneys prior to the obstruction. In another case in which renal function was impaired as a result of renal arteriosclerosis and urinary obstruction occurs secondarily as the result of a hypertrophied prostate gland, the excretion of phenolsulphonphthalein may indicate the degree of renal insufficiency produced by these combined factors. Undoubtedly, some degree of impaired renal function which is the result of arteriosclerosis exists in cases of prostatic hypertrophy. It is the arteriosclerosis and not the recent urinary obstruction that accounts for the decreased excretion of phthalein. Occasionally, when the output of urine is markedly reduced the excretion of phthalein may drop to a very low level, only because there is insufficient excretion of water to carry the phenolsulphonphthalein through the kidney. The nitrogenous waste products also require considerable dilution for their excretion; hence, when the daily output of urine is less than 250 to 300 cubic centimeters, the concentration of nonprotein nitrogen of the blood may reach considerable heights.

In spite of the foregoing limitations physicians have correctly depended on the estimation of the concentration of blood urea and the determination of the excretion of phenolsulphonphthalein for the evaluation of possible renal sufficiency in cases of prostatic hypertrophy. Since so much theoretical similarity exists between the excretion of urea and phthalein, the data on the estimation of excretion of phenolsulphonphthalein have been omitted from this report. In the present communication, data pertaining only to the concentration of blood urea and serum sulphate will be given.

In previous studies it has been observed that serum sulphate may be increased in cases of early renal insufficiency before either the urea is increased or the excretion of phthalein is decreased. The concentration of serum sulphate alone was increased in 19 cases (Fig. 1) in this study. The patients in these cases all had hypertension and arteriosclerosis. They had no residual urine or at most had less than 100 cubic centimeters. Clinically, of course, it was impossible to determine whether the nocturia and frequency of micturition which were present in these cases were symptoms of the prostatic enlargement or were attributable to the arteriosclerotic changes which resulted in a renal insufficiency. We often have seen a frank renal insufficiency develop in cases in which there was an increased concentration of

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serum sulphate. However, it is not always possible to interpret the significance of an increased concentration of serum sulphate on the basis of one determination. It might well be that the patient has had some acute renal disorder which is clearing up and that subsequent determinations of the concentration of sulphate would give results which were within normal limits. So far as we know, however, an increased concentration of serum sulphate is associated with a failure of renal function.

Under certain conditions which cannot be defined, there may be an increased concentration of blood urea while the concentration of serum sulphate remains within normal limits (Fig. 2). The clinical findings in the 31 cases in Figure 2 were the same as they were in the cases in Figure 1 except that hypertension was not present in all of the cases in Figure 2. However, in some there were moderately elevated blood pressures. On an average the residual urine was greater in the latter group.

The patients in the latter group of cases were of greater interest to us, first, because of the increased concentration of blood urea and the normal values for serum sulphate and, second, because of the progress the patients made while they were in the hospital. Figure 3 is a graphic representation of the value for the blood urea when fluids were administered by mouth and intravenously. The value for the blood urea rapidly returned to normal within a few days. In this figure only the value for the first determination of serum sulphate is given since subsequent values were also normal. These patients made uneventful recoveries after surgical relief of the urinary obstruction.

Usually, if there is an increased concentration of either blood urea or serum sulphate the concentration of the other is also increased (Fig. 4). This figure shows that in renal insufficiency the general trend is for the concentration of both blood urea and serum sulphate to increase. However, increases of these substances in the blood do not give any definite prognostic criteria.

The subsequent course after the oral and intravenous administration of fluids in cases in which there was an increased concentration of both blood urea and serum sulphate is shown

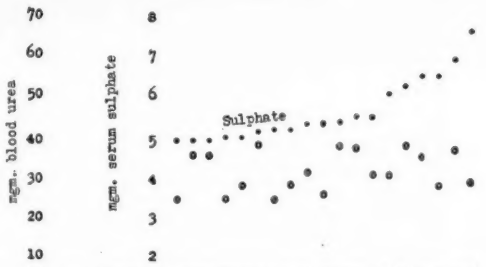

Fig. 1. Increased concentration of serum sulphate and normal concentration of blood urea in 19 cases. Dots, value for serum sulphate; o, corresponding value for blood urea in same case.

in Figure 5. The administration of fluids may cause a rapid decrease in the concentration of blood urea whereas the concentration of serum sulphate is not so quickly affected. This figure shows the general tendency for serum sulphate to be less easily affected by diuresis than the blood urea. However, the concentration of serum sulphate may be lowered by a prolonged diuresis just as is the concentration of blood urea. Occasionally, we have seen a value of 7 milligrams of sulphate (2.3 milligrams of sulphur) per 100 cubic centimeters of serum and a value of 100 milligrams of urea per 100 cubic centimeters of blood reduced to normal values in 4 or 5 days. It is the rule, however, that a fortnight or more may be required to reduce a value of 7 milligrams of sulphate per 100 cubic centimeters of serum to normal limits.

If one includes all patients who have been admitted to The Mayo Clinic on account of prostatic enlargement of sufficient degree to require a transurethral resection of the prostate gland, it will be found that the concentration of the serum sulphate and blood urea are within normal limits. The clinical examination, however, may be no different from some of those in which there were mild degrees of renal insufficiency. It is for this reason that tests which may indicate the state of renal function are important assets in outlining the future care of the patients who have prostatic hypertrophy and urinary obstruction.

EVALUATION

During the past several years we have determined the concentration of sulphate in the

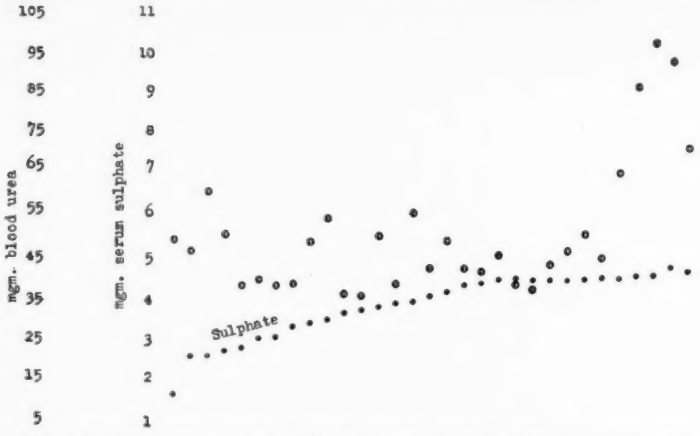

Fig. 2. Increased concentration of blood urea and normal concentration of serum sulphate in 31 cases. Dots, serum sulphate values; o, corresponding value for blood urea, same case.

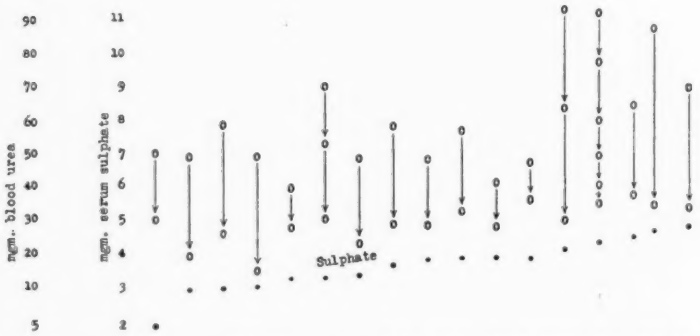

Fig. 3. Graphic representation in 17 cases of the effects of administration of fluids in cases of increased concentration of blood urea (indicated by c) and normal concentration of serum sulphate (indicated by dots).

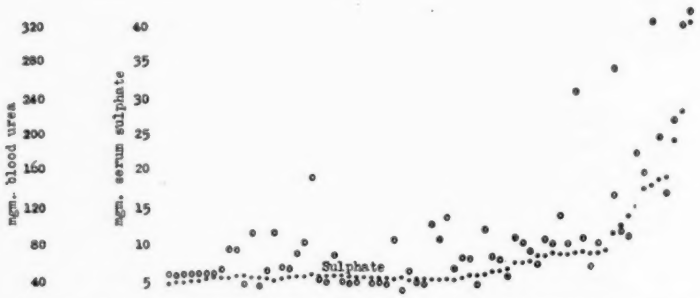

Fig. 4. Increased concentration of both blood urea (indicated by o) and serum sulphate (indicated by dots) in 70 cases.

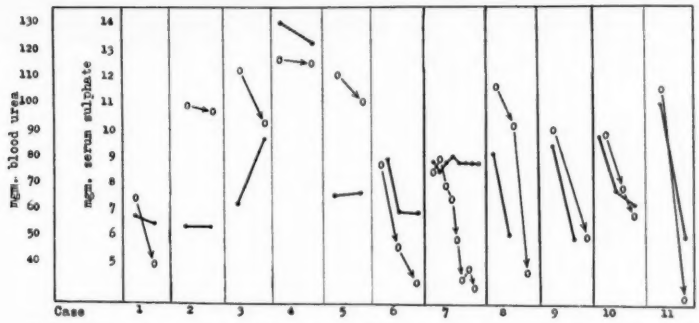

Fig. 5. The effects of administration of fluids when the concentrations of blood urea (o) and serum sulphate (dots) are increased.

serum in health and in disease. The concentration varies considerably among normal individuals. In series of 125 normal persons, the range of concentration of sulphates varied from 1.9 to 5.1 milligrams of sulphate (0.63 to 1.66 milligrams of sulphur) in each 100 cubic centimeters of serum. Fifty per cent of these values fell between 3.4 to 4.2 milligrams of sulphate (1.13 to 1.4 milligrams of sulphur) in each 100 cubic centimeters of serum. Statistically and for practical purposes, any value up to 5 milligrams (1.66 milligrams of sulphur) in each 100 cubic centimeters of serum is normal.

An increased concentration of serum sulphate before there is an increase in the concentration of blood urea may occur in arteriosclerotic disease of the kidney and in glomerulonephritis. This, however, is not a regular occurrence because the concentrations of these two substances usually are increased synchronously.

The increase in the concentration of blood urea without a concomitant increase in the concentration of serum sulphate in our experience has not been indicative of a serious disease of the kidney. However, we do not wish to postulate on this phenomenon with our present data. We have an impression that a patient who is not dehydrated and who has, let us say, from 80 to 100 milligrams of urea in each 100 cubic centimeters of blood does not have normal kidneys; however, in our experience the injury may not be profound. Adequate treatment may restore a normal renal function but not normal kidneys. Our data seem to indicate that an increased concentration of blood urea and a normal concentration of serum sulphate are related in some way to dehydration.

In brief, we believe that some worth-while information may be obtained from the determination of the concentration of serum sulphate. For instance, if diuresis reduces an increased concentration of blood urea to normal limits and if the value for serum sulphate remains more than 5 milligrams (1.66 milligrams of sulphur) per 100 cubic centimeters, we believe that the increased concentration of serum sulphate indicates a definite renal insufficiency; whereas, if the concentration of serum sulphate is within normal limits, the value for the blood urea may be disregarded.

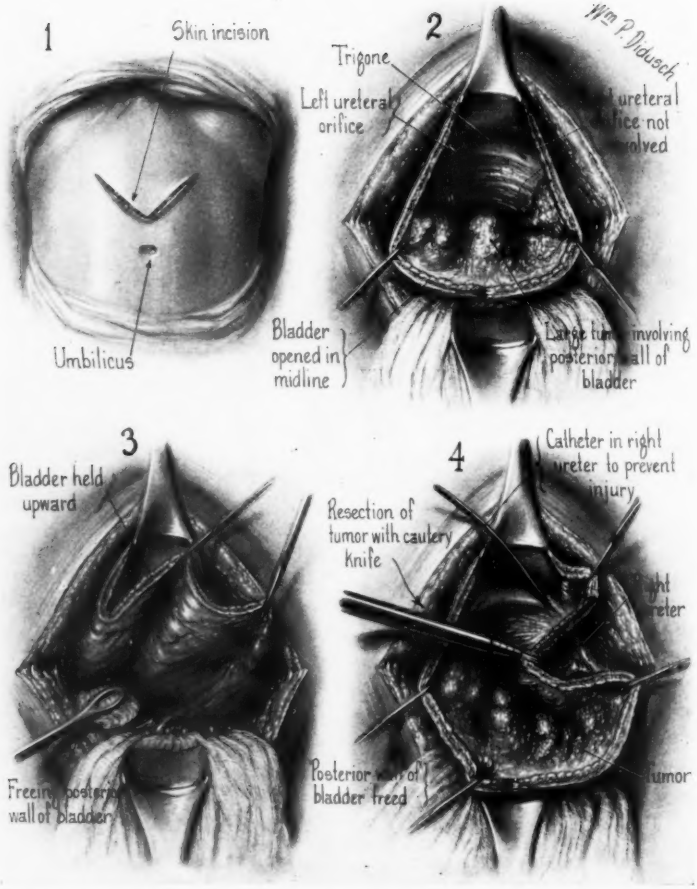

Fig. 5. Resection by cautery. 1, Skin incision; 2, bladder opened exposing tumor; 3, freeing posterior wall of bladder; 4, resection of tumor with electrocautery.

CLINICAL SURGERY

FROM JAMES BUCHANAN BRADY FOUNDATION, NEW YORK HOSPITAL

THE MANAGEMENT OF BLADDER TUMORS

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THE problem offered by the treatment of tumor of the bladder is not new, but our attempts to solve it have undergone constant change. It is a problem in which every member of the medical profession should take an active interest—whether he be specializing urologist or family doctor. Statistics show that 2 per cent of all tumors are located in the bladder. It is, therefore, a relatively frequent lesion, and one likely to be encountered by anyone engaged in the practice of medicine.

Though this tumor was recognized very early in the history of medicine, modern treatment did not really begin until the year 1910, when Edwin Beer of New York introduced his method of fulguration. Beer's discovery may be said to have revolutionized our whole conception of vesical growths, as well as our methods of dealing with them. Once Beer had led the way, the application of the high frequency current, and the invention of instruments combining cystoscopic and cautery features went rapidly forward, so that we now have at our command three different agents which may be used separately or in combination. These are: (1) surgery, (2) diathermy, (3) irradiation.

They may be employed according to the attending physician's personal judgment, as influenced by his experience and inclination, taking into consideration the location of the growth, its histological structure and stage of advancement. Especially important is the histological structure because of its bearing upon the radiosensitivity of the tumor.

The therapist charged with the treatment of a vesical growth will find plenty of help at hand, but it will often be difficult for him to select the particular method suited to the needs of his individual case. There will be but little trouble in doing this if the diagnosis of either benign or malignant neoplasm can be clearly established. It is with the atypical, border line case that he is likely to come to grief. Therefore, he should always avail himself of every modern means of diagnosis and correlate the findings of all methods available, namely, cystoscopy, biopsy, and cystography for it is only in this way that he can correctly evaluate the diagnosis.

The ordinary cystoscopic examination is often misleading. Though the foroblique lens system helps to show the tumor in its actual proportions and in proper relation to surrounding structures, no urologist should consider himself properly equipped unless he can also command a retrograde lens system as well as a right-angle lens system, enabling him to view the tumor in all aspects.

X-ray examination of the bladder filled with an opaque medium often gives us much valuable information; for cystography frequently fills in the gaps in the evidence presented by other maneuvers, and enhances their value. At the Brady Foundation of the New York Hospital both umbrathor and diadrast are used for this work. Irregularities in the outline of the bladder shadow may serve to locate a growth with accuracy, and though this method used alone might not be of great assistance, in conjunction with other diagnostic means, its importance is much enhanced.

Biopsy is, of course, the criterion by which all other means must be judged. In order to be sure of satisfactory specimens, I have designed a biopsy rongeur which has proved handy and efficient for this purpose. Malignancy often does not appear in a single specimen, if it be taken from one of the tendrils of a bladder tumor, with no part of the tumor-base included. Therefore, the specimen secured must be sizable enough to permit inclusion of "samples" of all constituent cell structures.

In our work at the Brady Foundation for Urology we do not adhere rigidly to any particular "grading" system. Neither do we regularly make use of any of the elaborate systems of classification which have been from time to time put forward for the purpose of differentiation of the intermediate grades intervening between the unquestionably benign and the frankly malignant

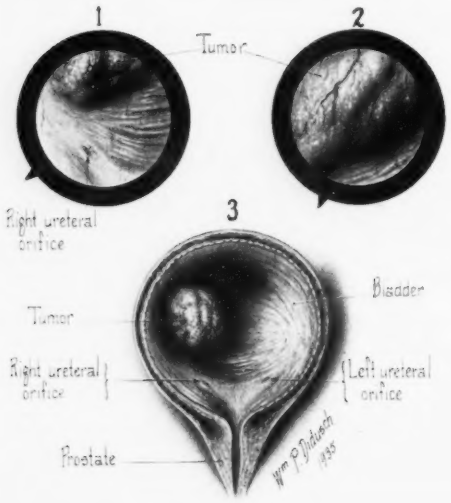

Fig. 1. Clamp method. Typical tumor of the bladder suited for excision by this method, showing the common position of such a tumor, and its most usual dimensions. 1 and 2, Tumor as seen through cystoscope; 3, reconstruction of cystoscopic findings showing position of tumor and approximate size.

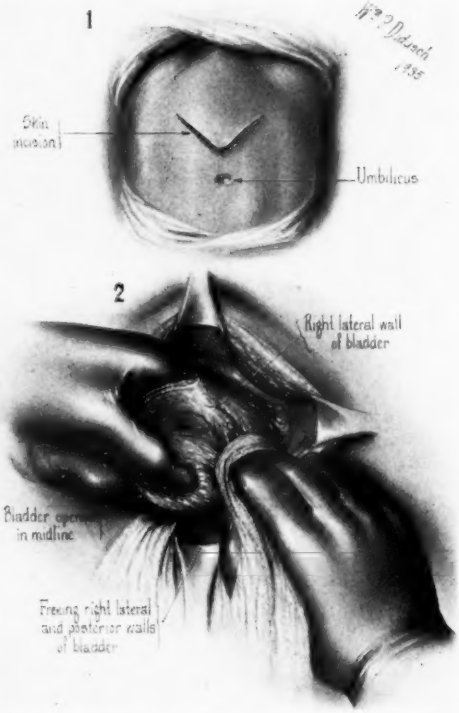

Fig. 2. Clamp method. Skin incision and the method of freeing the bladder's right lateral wall after it has been opened at the midline.

cell types. More and more we incline to the belief that *all* bladder tumors are potentially malignant, and whatever treatment be elected, we must bear in mind the necessity of providing against such future dangers.

The cystoscopist should familiarize himself with the fine differences in the aspect of the varied neoplasms which may possibly arise in the bladder. This can be attained only by constant practice and wide experience, but from the outset it should be the aim of all who attempt the treatment of bladder tumors. The surgeon cannot be expected to be also an expert pathologist, but he must keep in touch with all advances in the study of neoplastic diseases, and be ready at all times to give the specializing pathologist enthusiastic and intelligent support.

When the report from the pathological laboratory is received, it should be most carefully considered. Its findings must be compared with those obtained by rectal palpation, with the results of cystographic observation, and the checkings of cystoscopic study. When all these have been evaluated—separately and in their relations one to another—we should find ourselves in a position to take up consideration of the various possible methods of treatment, so that the procedure best suited to the needs of the particular case in hand may be unerringly selected.

TREATMENT

We have seen that there are now available for the management of bladder tumors three distinct types of treatment, which have been employed—separately or in combination—by the most experienced surgeons in this country and abroad. Considering these somewhat in detail we find:

Surgery. It has been statistically established that the majority of bladder tumors are inoperable from the outset because they are so located as to be inaccessible to surgery. Tumors arising on the lateral walls usually involve one or both ureteral orifices. Lateral wall growths comprise 41.89 per cent, and trigone and bladder-neck tumors 34.41 per cent of the 854 vesical growths classified in the Registry of the American Urological Association. The Carcinoma Registry Committee points out that this fact has an important bearing on treat-

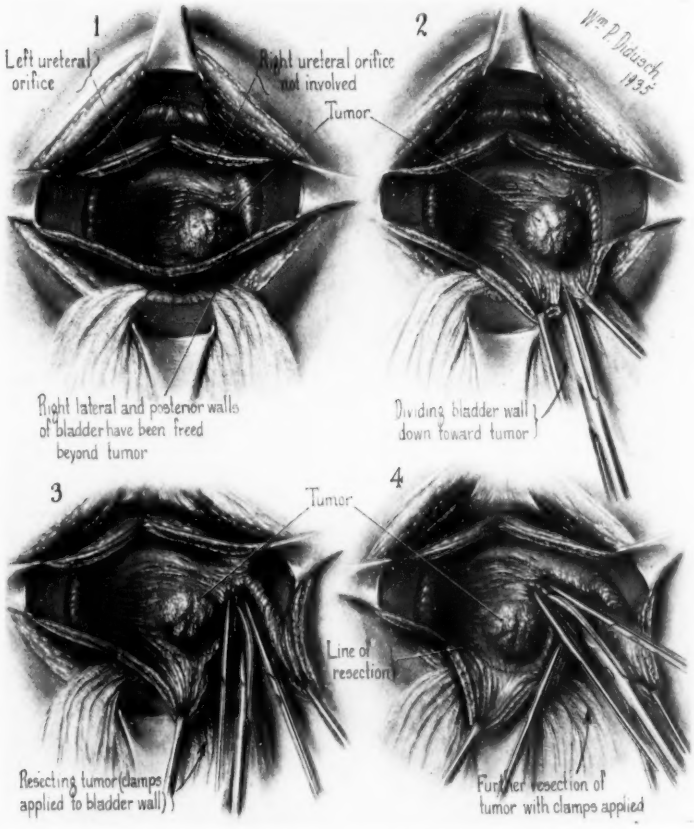

Fig. 3. Clamp method. 1, Bladder wall has been freed, and the tumor is exposed in its position upon the posterior portion of the right wall; 2, dividing bladder wall down toward tumor; 3, clamps applied to wall, resection begun; 4, further resection of tumor first applying clamps.

ment. From the surgical standpoint only 23.4 per cent of these tumors can be excised without interference with urethra or ureters. This means that surgical removal of tumors of the lateral walls almost invariably requires transplantation of one or both ureters, while those involving the trigone are surgically inapproachable except by using total cystectomy and bilateral ureteral transplantation. The report concludes: "It would appear, therefore, that any method of treatment to become generally acceptable must take into account the high percentage of bladder tumors in these areas, and the hazards of a purely surgical approach."

Some of our ablest surgeons, have recently expressed themselves favorably toward total cystectomy, but I cannot share this enthusiasm. The indications for cystectomy are very definitely limited. It is applicable only to bladders showing extensive papillomatosis entirely confined to the bladder mucosa, or where one or more larger tumors have infiltrated the bladder wall too widely to permit resection, but without extending beyond the bladder mucosa. It is useless to remove the bladder unless the patient can be proved free from metastasis, so a searching x-ray examination of all possible foci of malignancy in lungs, bones, or viscera adjacent to the bladder, is an indispensable preliminary.

As the majority of bladder tumor patients are in the late fifties or sixties, we must also consider their life expectancy. Is it worth while to perform

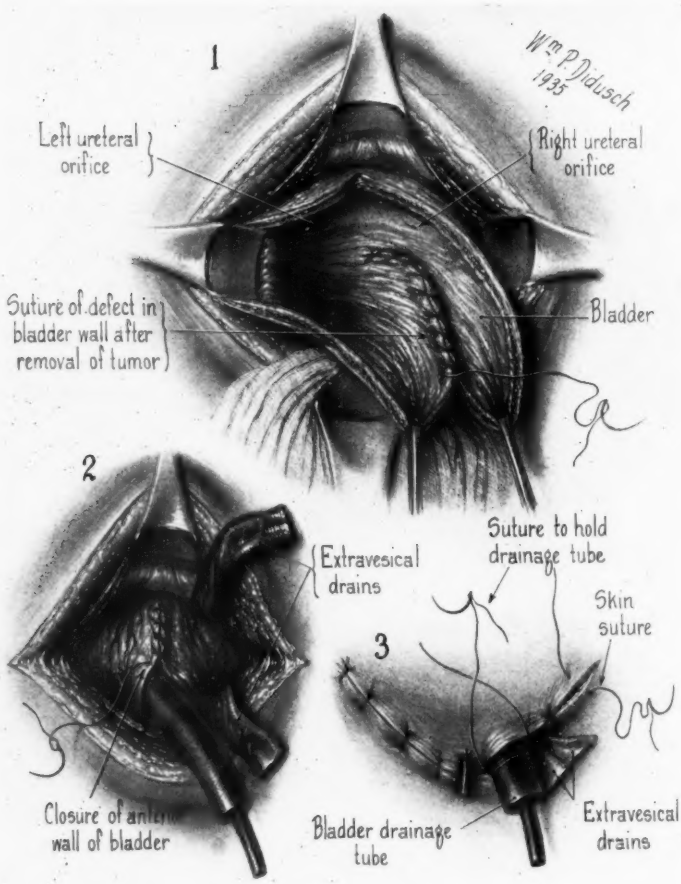

Fig. 4. Clamp method. The closure of the defect in the bladder wall, with placing of drains before sewing up the abdominal incision. 1, Suture of defect in bladder wall after removal of tumor; 2, closure of bladder, drains placed; 3, final skin suture.

so extensive and hazardous an operation as cystectomy upon a person who cannot expect, according to unbiased life insurance tables, such as those compiled by John Duff for the Metropolitan Life Insurance Company, to live more than a few years at best? As many of these people are greatly depleted by concurrent affections of heart, blood vessels, and kidneys, their life expectation is still more reduced.

Again, removal of the bladder involves implantation of the ureters into the sigmoid or other portion of the lower intestine. Most of the advocates of removing the bladder with the tumor pass very lightly over this problem of uretera implantation. I spent more than 3 years in investigation and animal experimentation upon this subject, performing the operation upon upward of 80 dogs. In practically every instance, although many of the dogs recovered promptly from the effects of the operation, they later succumbed to kidney infection or other secondary effects, and in those which lived long enough to permit their being sacrificed after a definite period, hydronephrosis and other sequelæ of infection and resulting urinary obstruction, were in evidence. This was frequently seen in animals whose opera-

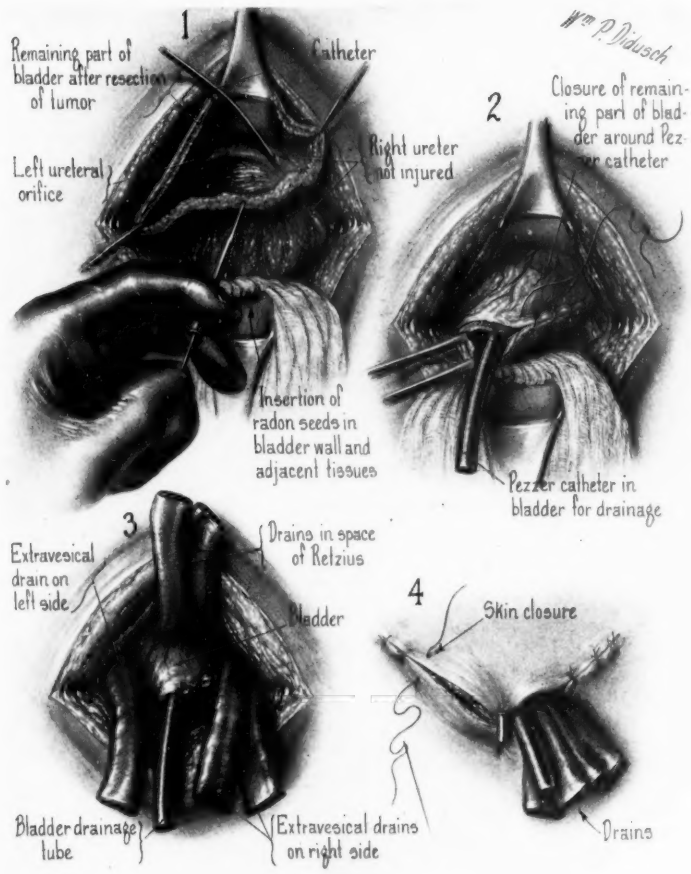

Fig. 6. Cautery method. 1, Method of "seeding" the cut edges of the remaining portion of the bladder wall before closing it; 2, closure of remaining part of bladder; 3, bladder closed, drains placed; 4, final closing of skin incision.

tive wounds were entirely healed so that surgically speaking the operation was a "perfect success." I became convinced that the difficulty lay in the injury sustained by the nerves of the ureteral walls when the ureters were severed from the bladder. The ganglion cells of these nerves apparently play the same rôle in peristalsis as do those of the Auerbach-Meissner plexus in the intestine. When their dendrites are cut, peristaltic waves are halted at the site of injury, even if no actual stricture has been formed. This fact was demonstrated by Alksne and by Gouverneur 25 years before I made my experiments and was observed in a human in whom the ureter had been cut by accident and had been sutured together when no infection was present. A dilated ureter and hydronephrosis were the result in each case.

In my opinion any operation involving ureteral implantation is not justified upon an elderly or enfeebled patient. If stricture of the ureter occurs at its place of implantation in the intestine, ureteral obstruction will be followed by hydronephrosis or pyonephrosis, with ultimate uremia and death. If actual stricture should not occur, peristalsis will be lessened or altogether inhibited, urine will collect behind the break in the continuity of the ureteral wall, and though it will

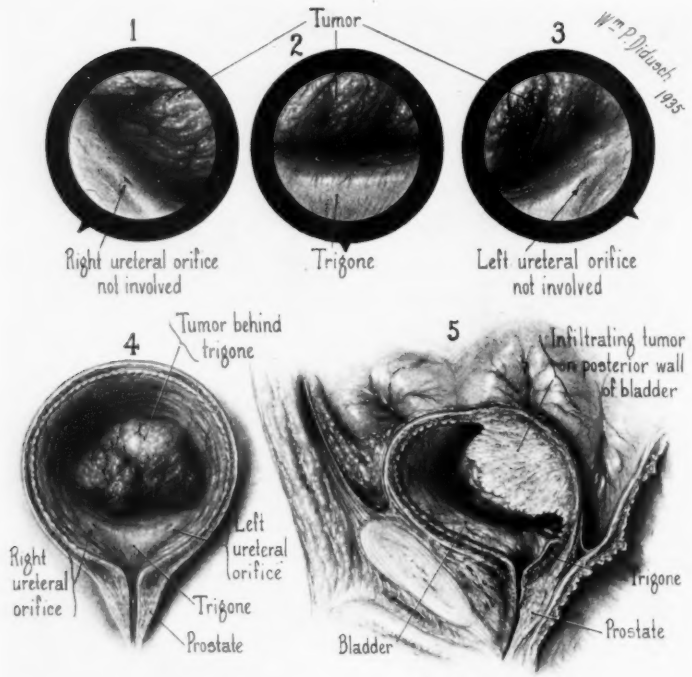

Fig. 7. Loop-ball-disc method. 1, 2, 3, Cystoscopic views of a large tumor behind the trigone, infiltrating the posterior wall of the bladder; 4, reconstruction of condition; 5, sagittal section showing position of tumor.

soon "spill over" and partially empty itself by gravity, eventual hydro-ureter is inevitable. An operation presenting such grave hazards should, in my opinion, be employed only in the rarest instances.

Diathermy. Since its introduction by Beer in 1910, diathermy or fulguration has been the surgeon's mainstay in the destruction of *benign* vesical tumors. For malignant growths it has never been satisfactory, as its originator freely admits. Excision by the cautery knife followed by irradiation, which may be looked upon as a "diathermic method," has been more successful, but recurrence too often follows the use of diathermy alone to make it seem desirable to the majority of operators.

Irradiation. While the use of radium and roentgen-ray therapy has proved a valuable adjunct to other methods employed in combatting bladder tumors radiation therapy alone has not been satisfactory. This is admitted by practically all therapists.

DESCRIPTION OF MODERN METHODS

After long experience with the various methods just outlined, a technique has been worked out which is now proving efficient in the majority of cases. For the minority to which this more or less standardized technique is not applicable variations are necessary, but these too have become quite well standardized, and their indications clearly established. They may be listed as follows:

Method I. Resection using clamps; excision by scalpel, followed by deep x-ray therapy.

Method II. Resection by cautery knife, with radon implantation before wound is closed.

Method III. Fulguration by loop and disc electrodes through a suprapubic incision, followed by implantation of radon seeds.

Method IV. Closed method: removal of exuberant portion of growth by the resectoscope, followed by intra-urethral implantation of radon seeds, and in some cases, external x-ray therapy.

Incisions. There are many types of incisions for approaching the bladder. The author usually

uses the midline incision. The director of the Brady Foundation of the New York Hospital, Lowsley, prefers the inverted "V" in most cases feeling it gives him an opportunity to make a wider resection of the bladder if necessary, by the cutting of the recti muscles. There are urological surgeons who prefer the Pfannenstiel incision. These are all personal equations that the surgeon must solve himself and have very little bearing on the actual resection of the bladder tumor itself.

Clamp method. In Figure 1 is shown a typical tumor of the bladder suited for excision by the clamp method, showing the common position of such a tumor and its most usual dimensions. In Figure 2 is shown the skin incision and the method of freeing the right lateral wall of the bladder after it has been opened at the midline. In Figure 3 the bladder wall has been freed, and the tumor is exposed in its position upon the posterior portion of the right wall. The bladder wall is divided downward toward the tumor, the clamps being applied to the wall as resection begins. Figure 4 shows closure of the defect in the bladder wall, with placing of drains before sewing up the abdominal incision. The value of this procedure is enhanced by irradiation after resection is completed, as we thus take care of any possible extension of the malignant process which may have remained outside the line of resection.

Cautery method. Figure 5 (frontispiece) shows resection by cautery—skin incision, opening of bladder wall and removal of large tumor at base of bladder. In Figure 6 we have illustrated, 1, the method of "seeding" the cut edges of the remaining portion of the bladder wall before closing it; 2, closing of the wall about a Pezzer catheter; 3, placing the drains; and 4, final closing of the skin incision. This method may be employed when for any reason loop and disc electrodes are not available.

The technique next to be described is considered preferable by the author whenever possible.

Loop-ball-disc method. For large tumors, impossible to remove by the intra-urethral route, excision with the loop electrode through a midline incision has proved most satisfactory to me. In Figure 7, 1, 2 and 3, are shown cystoscopic views of a large tumor behind the trigone, infiltrating the posterior wall of the bladder. Figure 8 shows details of the three different electrodes employed in carrying out the technique. In Figure 9, 1, the ball electrode is applied to the wall encircling the tumor. In Figure 9, 2, the entire tumor mass is being removed with the loop electrode while Figure 9, 3, depicts the method of applying the disc electrode to the base of the tumor after the exuberant portion has been excised, to control any hemorrhage that may be present. When the entire site has been thoroughly cauterized, radon seeds are implanted, as demonstrated in Figure 9, 4, so as to take care of any infiltration which may have taken place in the muscular wall of the bladder.

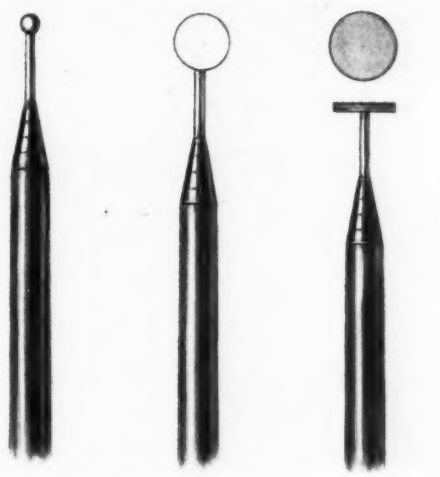

Fig. 8. Details of three different electrodes employed in carrying out the technique.

Combination closed method. Except when a tumor is too large to be handled by intra-urethral methods, or the conditions under which operation must be performed will not permit the use of the necessary instruments, the following technique will be found by all means the most satisfactory for the ordinary bladder neoplasm. In essence, it is the same as method III just described, although it is performed intra-urethrally instead of through a suprapubic opening.

The size of the tumor is first ascertained. For this purpose I have designed with the assistance of Mr. F. C. Wappler, an instrument which facilitates both inspection and measurement, permitting correct estimation of the amount of radon dosage required to irradiate the base after the mass of overgrowth has been removed by loop electrode of the McCarthy or Kirwin resectoscope. When the measurements have been taken the instrument is withdrawn, the resectoscope is substituted, and the growth is cut away with the loop, as shown in the drawing of the suprapubic method, Figure 9, 2.

When the growth has been cut away and the site cauterized by the resectoscope, radon seeds

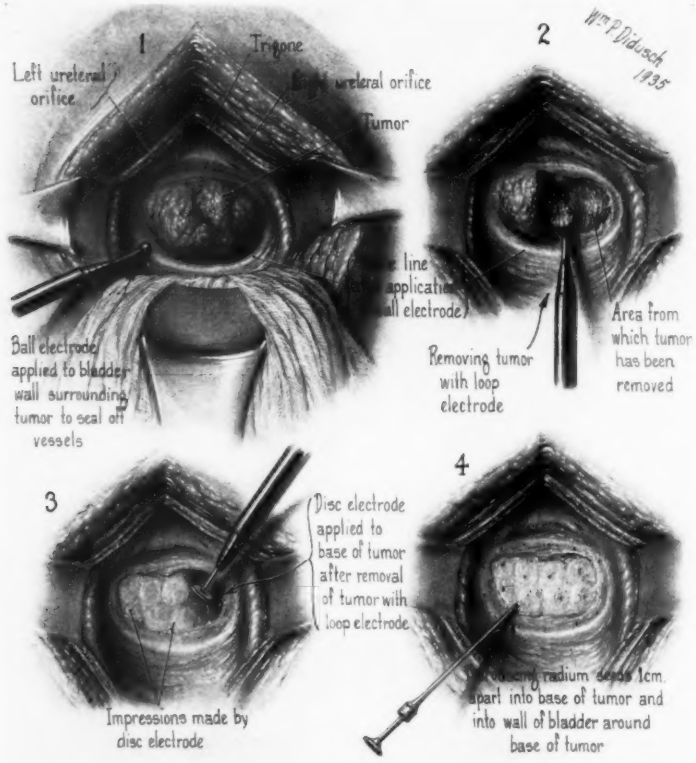
1
Trigone
Left ureteral orifice
Tumor
Ball electrode applied to bladder wall surrounding tumor to seal off vessels
2
Wm P Didusch 1935
Area from which tumor has been removed
Removing tumor with loop electrode
3
Disc electrode applied to base of tumor after removal of tumor with loop electrode
Impressions made by disc electrode
4
apart into base of tumor and into wall of bladder around base of tumor

Fig. 9. 1, Ball electrode is applied to wall encircling the tumor; 2, entire tumor mass is being removed with loop electrode; 3, method of applying the disc electrode to the base of the tumor after the exuberant portion has been excised; 4, implantation of radon seeds.

are at once implanted in the affected area, the introducer designed by the author being used. This introducer can be inserted through the measuring arm of the first instrument, if it is found desirable.

The Kirwin resectoscope is particularly well adapted for removing the exuberant portions of the tumor because its electrode rotates behind a fenestra, and is thus much less likely to cut through the bladder wall, even when it has been weakened and thinned by malignant infiltration. When a special instrument is not at hand, ordinary fulguration may be used to remove the visible tumor mass. The important feature is the scraping away of all the projecting mass, so that the base may be fully exposed for radon implantation. Application of the disc electrode will then leave a clear surface ready to receive as many radon seeds as the measuring instrument has indicated to be necessary.[1]

This operation by the closed route minimizes shock, produces little or no hemorrhage, and can be borne by even a greatly enfeebled patient better than an open operation in which a spinal or general anesthesia would be hazardous. I believe it should be used in preference to any other, except in cases of very large tumors when intraurethral methods are technically impossible. It is only under unusual circumstances that the surgeon will be so situated that he cannot employ one of these combination procedures. However, should this situation arise I believe the loop-ball-disc method is preferable if, owing to the size of the tumor, a cystotomy is necessary.

[1]For a more detailed description of the instruments mentioned see J Urol., 1937, 38: No. 2.

CONCLUSIONS

The treatment of bladder tumors still offers many difficulties to the surgeon, despite great advances in pathological study and the design of instruments providing means of intervention which were impossible a few years ago.

Effort has been made to demonstrate that adherence to any one technique in dealing with vesical tumors whenever and wherever found, is a fundamentally unsound practice. No one method can be adapted to all cases.

Radical surgery is still widely practiced by eminent members of the urological profession. Extensive series of cases of total cystectomy have been reported for which considerable success has been claimed. The author regards any operation involving ureteral implantation as unjustified for use upon elderly and enfeebled subjects such as the majority of bladder tumor patients, and at best as a hazardous procedure with a highly uncertain outcome.

The principal methods of treating tumors of the bladder are offered together with a technique which will fulfill the requirements of conservative practice in the great majority of instances. It is recommended as combining the excellencies of all three standard methods, while eliminating the drawbacks to which each is subject when used alone.

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SURGICAL FUSION OF THE WRIST JOINT

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SURGICAL fusion of the wrist joint for deformities and disease is relatively new. Very little is presented in the literature concerning the subject. No conditions other than tuberculosis, poliomyelitis, paralysis of the radial nerve in war fracture of the humerus, affection of the wrist joint in syringomyelia, and brachial plexus paralysis, have been given as the etiological indications for such operations. Except for tuberculosis, no author has presented more than 1 case, and in none of the cases is there a detailed report of the follow-up and end-result. Ely offered a fusion operation for tuberculosis of the wrist in 1920 and presented 2 cases. Blanco in 1933 published 16 cases after the method of Ely.

This paper is a presentation of 44 consecutive and unselected cases in which fusion of the wrist has been performed for 8 different conditions, namely: tuberculosis, rheumatoid arthritis, obstetrical paralysis, poliomyelitis, fracture dislocation, Volkmann's paralysis, gonorrheal arthritis, and spastic paralysis. The average follow-up is 4.1 years, and the end-results are given in detail.

TUBERCULOSIS

History. The treatment of tuberculosis of the wrist until recent years has been highly unsuccessful. Long ago it was realized that operative treatment was indicated. In fact, it has been nearly a hundred years (1839) since Dietz performed the first resection for caries of the wrist joint, and since Dupuytren (1846) wrote, "it is the slow, insidious inflammation of the wrist, terminating in the white swelling for which we are so often obliged to have recourse to amputation."

Though resection had its adherents, it came more and more into disrepute because it left the hand useless, and because excision often was repeated and repeated until pyogenic infection developed, making amputation necessary if the life of the patient was to be saved. Therefore, attempts to preserve function of the extremity while curing the disease, were inevitable. Fifty years later, in 1881, Macnamara suggested ankylosing the involved joint when he said, "if we can secure ankylosis without excision, the patient will, as a rule, have a much better hand than he is likely to gain after the resection of the bones. . . ." Furthermore, he did not approve of resection for those cases too far advanced for ankylosis and added, "If the condition of the patient and the limb is such as to preclude all hope of recovery I should advise amputation rather than resection of the joint and, in truth, in several cases of resection of the wrist-joint the patient would have been better off with an artificial hand than with the mutilated remains of the one left after the operation (resection)."

Coote in 1867 considered that the maintenance of bodily strength and complete rest for many months, or even years, was the treatment of choice. He believed further that, "No operation can be of any avail," although he stated that in very severe cases in adults amputation might be necessary.

Injection of iodoform emulsion into each bone and joint at the wrist was described by Senn in 1892 with the admission that the functional results were better than those obtained by resection "in case the treatment proves successful."

More accurate descriptions of the disease began to appear around 1900, but it was not until 1920 that Ely offered an operation for fusion of the wrist. By this method a tibial graft is placed between the base of the third metacarpal bone and distal end of the radius. Other types of bone grafts have been suggested also and today fusion is considered to be the treatment of choice, although as late as 1930 Whitman recommended splints, and in severe cases early excision of the wrist with amputation as a final resort.

The first wrist fusion performed at the New York Orthopædic Dispensary and Hospital was by Dr. Russell A. Hibbs on April 23, 1919 (case No. 27362). Up to July, 1935, 23 patients were operated upon for tuberculosis of the wrist at this hospital. Twelve of these were females and 11 were males. The disease affected the right wrist 11 times and the left wrist 12 times.

Quite surprising was the fact that in 6 of these 23 patients, the disease spread from a primary lesion in the wrist joint to involve the ulnar epiphysis later, and conversely, in 1 case, tuberculosis spread from the primary focus in the ulnar epiphysis to involve the wrist joint. This

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Fig. 1.

Fig. 1. Tuberculosis of wrist of many years' duration without operative treatment. Anteroposterior and lateral views. Note in both roentgenograms that the ulnar epiphysis is not involved.

Fig. 2.

Fig. 2. Same case as in Figure 1, 1 year 9 months later. Anteroposterior and lateral views. Compare with Figure 1 and note in both views that disease has spread and that ulnar epiphysis now is involved.

finding seemed most unusual to me because the distal end of the ulna is blocked from the wrist joint by the interarticular fibrocartilage. Therefore, I undertook special work to try to determine the reason for the spread of the disease in this particular area.

A THEORY AS TO THE ETIOLOGY OF SECONDARY TUBERCULOUS INVOLVEMENT OF THE ULNAR EPIPHYSIS FOLLOWING A PRIMARY TUBERCULOUS FOCUS IN THE WRIST JOINT

The ulnar epiphysis is not a part of the wrist joint. It is prevented from so being by the interposition of the triangular interarticular fibrocartilage which separates the distal end of the ulna from the lunate and triquetral bones.

In this series of 23 cases, secondary involvement of the ulnar epiphysis, or of the wrist joint, occurred 7 times, or in 30.4 per cent of the patients.

In 6 of these 7 cases, the wrist joint was involved primarily with the disease spreading to the ulnar epiphysis later (Figs. 1 and 2). These 6 cases had no symptoms or roentgenographic findings referable to the distal end of the ulna for an average of 18.6 months after the condition present in the radiocarpal joint had been diagnosed as tuberculous.

In the 1 remaining case, the disease spread from the ulnar epiphysis to the wrist joint (Fig. 3). In this instance it is not known how long after symptoms developed in the distal end of the ulna that the radiocarpal joint became involved, but the roentgenograms revealed a large cavity in the ulnar epiphysis while only slight decalcification was present at the triquetral and pisiform bones, and it was much later before destruction occurred at the distal end of the radius. This indicates that the process was of much longer duration in the ulna than in the radius.

It is well known that the articular fibrocartilage excludes the ulna from the wrist joint. It is likewise well known that cartilage is one of the most resistant of tissues to tuberculosis. To try to explain, therefore, the extension of disease from one joint to the other, particularly from the radiocarpal joint to the distal end of the ulna, cadaver dissection was undertaken by the author at Columbia University College of Physicians and Surgeons. Eighty unselected cadavers laid out for anatomical study over a period of 2 years were used and 160 wrists were examined personally. The triangular interarticular fibrocartilage of each wrist was studied carefully. Seventy-four of these were normal, the central portion of the disk being about 3 to 5 millimeters in thickness. Thirty-seven

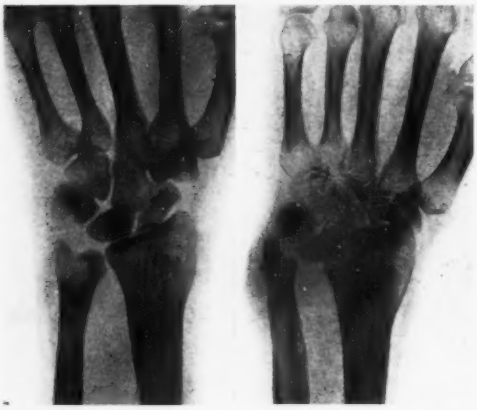

Fig. 3. Tuberculosis of ulnar epiphysis. Anteroposterior views. On the left note large radiolucent area at distal end of ulna and only slight involvement of triquetral and pisiform bones of wrist. On the right is same case 1 year 1 month later. Note that disease has spread and now has destroyed the wrist joint.

presented only a very thin membrane covering the center of the disk. These membranes were of the thickness of tissue paper and were as easily ruptured. Forty-nine, or 30.6 per cent, were definitely perforated, the perforation varying in size from 1 to 14 millimeters (Fig. 4). The perforation was bilateral in all cadavers except 5, but the 5 disks on the opposite side that were not perforated were extremely thin.

A few books on anatomy do not mention that the articular disk at the wrist may be perforated (Spalteholz, 7th edition in English). The latest editions of five standard textbooks on anatomy merely mention the perforation by saying: "It (the disk) is in some cases perforated" (Piersol, 1930); "the articular cavity (of the wrist joint) is sometimes continuous with that of the distal radioulnar joint" (Morris, 1933); "There is no communication between the radio-ulnar joint above and the radiocarpal joint below, except when, as occasionally happens, the triangular cartilage has a perforation" (Davis, 1934); "(the disk) is occasionally perforated" (Gray, 1936); and "in some cases the disc is perforated" (Cunningham, 1937). Because the incidence is not given there are no data available with which the findings in this study may be compared.

Upon the figures here obtained it appears that there is a definite relationship between 30.6 per cent of perforations of the articular disk at the wrist and 30.4 per cent of secondary ulnar or wrist involvement when tuberculosis affects primarily either of the joints. The presence of the opening in the disk destroys the barrier that normally exists between the ulna and wrist. It may be possible, but the above percentages do not substantiate it, for the thin membrane across the disk to be ruptured by swelling and pus under pressure.

TABLE I.—AGE AS TO YEARS

Age—years	Cases
20 to 30	9
31 to 40	5
41 to 50	2
51 to 60	3
61 to 70	1

It seems plausible, therefore, to assume that when disease of the distal end of the ulna follows disease of the wrist joint, or occasionally vice versa, it is due to a developmental perforation of the triangular interarticular fibrocartilage.

Age. Most authors state that tuberculous disease of the wrist is rare in youth. In this series 3 patients, or 13 per cent of the group, were not over 16 years of age. The ages were 5, 7, and 16.

The 5 year old girl was brought here from an asylum and the duration of symptoms was unknown. She was kept at the country branch of this hospital for 1 year and fusion was performed at the age of 6. She was discharged against advice 4 months later and taken to Italy. The end-result remains unknown.

The 7 year old boy had had symptoms for 1 year. Fusion was done 1 month after tonsillectomy had been performed. Refusion was necessary 9 months later and 1 year from the last operation the patient had a solid fusion and was symptom free (Figs. 5 and 6).

The 16 year old girl had had symptoms for 2 months. Fusion was done at once and 9 months later the wrist was solid and the patient was cured.

The number of patients in the other age groups is shown in Table I.

This table indicates that tuberculosis of the wrist is most common during the 2 decades of 20 to 40 years, and that it is not unknown in youth or in old age.

Familial history. History of tuberculosis in other members of the family was not conclusive since in 9 of the cases it was not recorded. Eleven patients, however, denied the presence of familial tuberculosis while there was a positive history in 3 cases.

Previous treatment. The average period of time before proper treatment was instituted for these patients was 4.6 years. In all but 2 cases the previous treatment involved procedures that should have been avoided, such as heat, massage, incision of swellings, diathermy, wet dressings, and baking. It would have been much better to have given no treatment at all than to have employed such harmful procedures. Stress, therefore, should

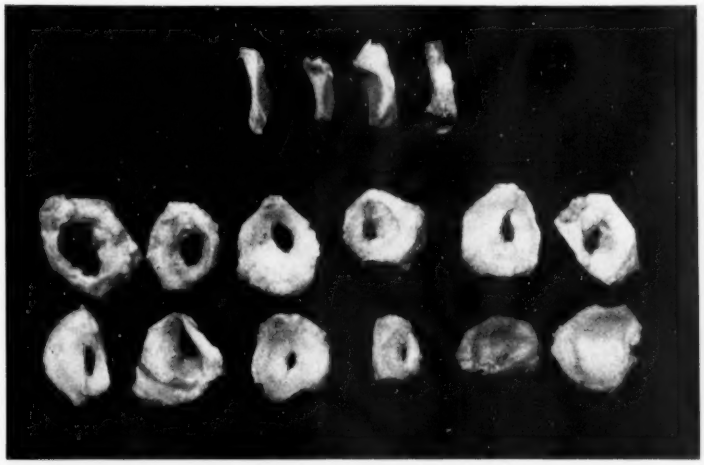

Fig. 4. Interarticular fibrocartilages showing variation in thickness of disks and in size of perforations. Top and bottom rows have normal disk on the right for comparison.

be laid upon early and accurate diagnosis through aspiration and guinea pig examination so that loss of valuable time and improper treatment may be avoided.

Symptoms. Duration of symptoms varied greatly. The shortest period was 2 months and the longest was 28 years. The onset of symptoms was slow or sudden. Six of the patients had previous tuberculous foci elsewhere in the form of pulmonary, lymph node, fallopian tube, or tendon sheath involvement. Nine attributed the onset to injury. Long hours, hard labor, damp surroundings, and night work, were given by others as the cause of a generalized run-down condition which was present prior to the onset of symptoms. In some patients the original pain was first felt in the index finger, in others in the third and fifth fingers. Stiffness of the fingers was followed by intermittent aching which often increased until the patient was awakened at night by pain. The swelling, pain, and stiffness of the wrist and fingers, slowly but steadily increased until the patient gave up work and finally consulted a physician.

Physical examination. Typical physical findings are those of a swollen wrist joint, held in a protective manner, generally in the position of slight flexion and pronation. Motion is slight and all attempts to move even the fingers are limited by marked pain and spasm. Grip and active muscle power are poor. Localized heat and redness may be present at times to a slight degree but generally are absent. Tenderness about the wrist is exquisite. Fluctuation over the ulnar head may occur if the ulnar epiphysis is involved. Bogginess often is present. In contrast to the periarticular swelling is the marked degree of atrophy of the forearm, sometimes measuring 2 inches in comparison with the normal side. Sinus formation is not as frequent as one would think and, before operation, is rare. When the tendon sheaths are involved, fusiform swellings and soft tumors occur about the wrist and hand.

Roentgenographic examination. Roentgenograms early in the disease (Fig. 5) reveal smoky decalcification with marked swelling. The cartilage space at the radius is thin. There is no bony productive reaction. Late roentgenograms (Fig. 7) show radiolucent areas; erosion of articular surfaces; effusion, often marked and sharply outlined; decalcification; and thin cartilage spaces. Sequestra at times are present.

Procedures preliminary to fusion. Several procedures should be carried out preliminary to fusion of the wrist. Tonsils should be examined and removed if necessary, particularly in children. Duncan states that tonsils were removed from 100 patients with joint tuberculosis and upon microscopic section were found to be tuberculous in 24 cases. Since pulmonary tuberculosis is so often associated with tuberculous wrists, roentgenographic examination of the chest should be made. In this series, roentgenograms were available in 13 cases and of these, 4 were positive before operation for active pulmonary tuberculosis. None that was negative before operation became posi-

Fig. 5. Fig. 6.

Fig. 5. Tuberculosis of wrist in child aged 7 years. Anteroposterior view of diseased wrist on left compared to normal before operation. A roentgenographic example of tuberculosis early in the disease.
Fig. 6. Same case as in Figure 5, 1 year after refusion. Anteroposterior and lateral views. Note ulnar deviation of 20 degrees, the third metacarpal being off center and not in straight line with forearm.

tive after operation. The history and physical examination should be used as further checks upon other tuberculous foci. Frozen section examination should be performed in every case at the time of operation and no fusion should be carried out in the presence of a negative report except when the joint is so disorganized that fusion is the procedure of choice, irrespective of diagnosis. Upon a negative report, with the joint not appearing too diseased and without destruction of cartilage, closure of the wound should be made. If the permanent sections or guinea pig inoculation show tuberculosis, fusion of the wrist should be performed at a second operation.

Tourniquet technique. The operative procedure is made easier by the use of a tourniquet. This should be applied after all blood has been evacuated from the extremity by carefully carrying an Esmarch bandage up the arm from the finger tips. The constricting portion of the tourniquet should be broader than that used upon the lower extremity because the upper extremity presents more superficial nerves and less subcutaneous fat. It should be a pneumatic cuff that will not leak because a leaking tourniquet allowing venous stasis is more apt to produce paralysis than a tight tourniquet producing pressure on the nerves. In this series, tourniquets were used on all the patients and no paralyses occurred although the operating time alone varied from a minimum of 47 minutes to a maximum of 1 hour and 37 minutes.

Fusion technique. Many factors enter into obtaining a solid fusion of the wrist and they are discussed in various parts of this paper. Here I wish to mention the difference between small bone chips and large bone grafts in regard to fusion.

During the period the bony mass is becoming vital, irrespective of whether the mass consists of many small chips or a single large graft, absorption progresses, the mass remains discreet and fractures occur easily. Union of the mass takes place quite early in comparison to complete revitalization. In the case of bone grafts it takes a great length of time for the transplanted bone to change from an inert state to a vital state. This period of time depends upon the cross-sectional size of the graft. In the case of small chips it takes a much shorter period of time for the bone to change to a vital state because the surface area of the chips is much greater and the cross-sectional size of the chips is much smaller. The expected time for extensive revitalization to occur when small chips are used is several months, while in the large grafts a comparable state does not develop in less than several years.

Since it is desirable to obtain revitalization as quickly as possible, in order to arrive at a state of

safety (Fig. 7) where the danger of absorption and fracture of the fusion area is eliminated, small bone chips are considered better than large bone grafts.

The bone chips are obtained, as the occasion demands, from various parts of the skeleton but usually from the distal third of the radius, which may be exposed through the same incision. Further, the cartilage of each carpal bone to be fused is removed, and portions of these bones are broken down into chips. When these sources are not sufficient, the ilium or the tibia is used. All chips are made quite small, generally about 12 by 3 millimeters. In a few of the earlier cases large bone slabs and grafts, ranging in size from 1¼ by ¾ inches to 2½ by ¼ inches, were placed across the radius and denuded carpal bones. Union in these cases was slower, the average time being 8 months, while in those cases in which small chips were used, the average time was only 6 months.

Operative technique. The skin incision is made dorsally between the extensor pollicis longus and extensor indicis proprius. The incision is a longitudinal one and need not be longer, generally, than 8 centimeters. The subcutaneous tissues and dorsal carpal ligament are incised. The extensor pollicis longus and extensor carpi radialis brevis are retracted radialward while the extensor indicis proprius and extensor digitorium communis are retracted ulnarward. The capsule is opened and the radiocarpal joint exposed.

From this point on the operation depends upon the pathological findings. Generally, only those joints involved are fused although the better functional and cosmetic results in this group were those in which the radius, both rows of carpal bones, and all the metacarpal bones, except the first, were solidly fused. The latter is considered the better procedure.

The distal epiphysis joins the diaphysis of the radius at about the twentieth year. In patients younger than 20, care is taken not to injure the epiphyseal cartilage. However, when the area has been partially destroyed by disease, the remaining portion may be excised to prevent unequal growth, and fusion is carried out as described.

When diseased, the distal end of the ulna is resected. This often gives an unsightly defect, as if the hand were displaced medially; and slight medial motion, in spite of the radius being fused, may be the result. However, fusion of the ulna to the carpus should not be attempted because it would not only be difficult to perform, but also would prevent the movements of pronation and supination and thus produce an incapacitating deformity.

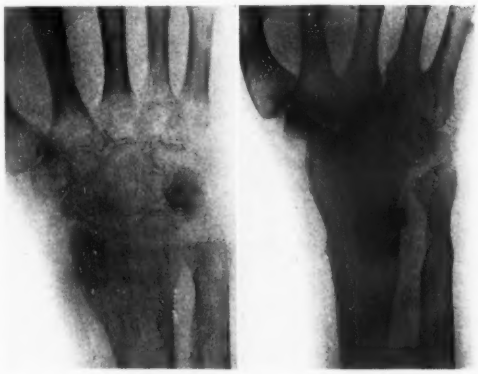

Fig. 7. Tuberculosis of wrist. Anteroposterior views before and after operation. The left is a roentgenographic example of tuberculosis late in the disease. The right is same case 1 year 6 months after fusion with fracture of radius and ulna demonstrating strength of fusion area.

It is not considered necessary to remove all the diseased tissue and, in fact, such is impossible at the wrist. However, it is necessary that all cartilage be removed from the joints to be fused, except on the anterior aspect. Often destruction may be so great as to require the complete removal of a bone. Unless diseased, and none was in this group, particular care is taken not to enter the first carpometacarpal joint because complete motion of the thumb is extremely important to the patient. If disease should be present at this joint, resection would be preferable to fusion because of the importance of thumb motion.

An adequate number of bone chips, which means a large amount, are placed in all the spaces where bone destruction has occurred, as well as between the various bones to be fused, and particularly over the dorsum of the radionavicular joint.

Closure is by interrupted sutures throughout because of the danger of the wound breaking down. It is felt, also, that although proper closure will not obviate all sinuses it will materially affect their incidence. Every attempt is made, as difficult as it may be, to close the capsule as far as possible. This aids in preventing adhesions about the tendons as well as leakage from the joint. The dorsal carpal ligament is carefully united. The subcutaneous tissues are closed with interrupted plain catgut sutures and the skin edges with interrupted silk sutures.

Plaster technique. Many casts following fusion are applied no higher than the proximal forearm. This is believed to be wrong: because it violates

Fig. 8.

Fig. 8. Tuberculosis of wrist. Wrist in plaster after operation showing in anteroposterior view proper neutral lateral position with third metacarpal in line with forearm and in lateral roentgenograms proper degree of extension (30 degrees).

Fig. 9.

Fig. 9. Same case as in Figure 8, 2 years 6 months after operation, showing solid fusion. Anteroposterior and lateral views. Compare with Figure 8 and note that neutral lateral position has been maintained but that proper degree of extension has been lost.

the rule of immobilizing one joint above and one joint below the area involved; because the principal area to be fused in a wrist fusion is the radionavicular joint, and a cast that does not immobilize the elbow and thereby eliminate rotation of the radius, cannot completely immobilize the radionavicular joint; and because a cast extending above the elbow allows much more comfort to the patient immediately after operation, which fact may be observed at the bedside. In this series the data were not sufficient to offer definite proof that casts applied no higher than the proximal forearm cause failure of fusion but it is felt that the presence of rotation mobility is a factor in some cases of pseudarthrosis.

In addition to extending above the elbow, the cast should always extend to the finger tips. This is also more comfortable for the patient because the hand is better immobilized. If contracture deformity of the fingers is present, and often it is, the fingers should be held extended 45 degrees in order to stretch the flexor muscles. When the thumb presents no deformity it should be left out of plaster, and because there is a great tendency for pressure to occur at the base of the thumb, the cast should be cut well back of the first carpometacarpal joint rather than just down to the metacarpophalangeal joint, as so frequently happens.

Another point I wish to emphasize, is the promiscuous changing of casts in order "to take a look and get an x-ray." To remove a cast and apply another one produces motion, pain, and change of position, at the involved joint. The cast should be changed 2 weeks after operation in order to remove the sutures, inspect and dress the wound, and overcome the effects of swelling. Then a lighter, more snug and comfortable cast is applied and left on an additional 10 weeks. In this group of 23 cases union took place no sooner than 12 weeks and the average period was 24 weeks. Assuming, therefore, that at least 12 weeks are necessary for fusion to occur, it would seem unnecessary to change casts before that period, except during the second postoperative week, as stated, unless there is a better excuse than to take a roentgenogram. There are two reasons for this attitude. First, as to fusion. It is practically impossible, no matter how much one tries, to prevent motion at the involved joint which in turn may not only retard but be the cause of failure of fusion. Second, as to mainte-

nance of position. Normally the flexors at the wrist are much stronger than the extensors. Further, often at operation the fingers are in an already contracted state. Therefore, when support is removed there is a great tendency for the wrist to flex. Assuming that the wrist is in proper extension it is quite doubtful that the same amount of extension will be present, due to the factors named, after the cast is changed. (Compare Figure 8 with Figure 9.) In only 2 of the 23 cases presented here was the same amount of extension present when fusion occurred as was present immediately after operation.

Position of function. At the beginning of the twentieth century, mention was first made in the literature that the position of hyperextension should be obtained when splints are applied to a tuberculous wrist. Now that fusion is the accepted treatment for tuberculosis of the wrist, it becomes more necessary that attention be paid to the proper postoperative position. A hand hyperflexed or hyperextended has a poor grip. A hand at 180 degrees, i.e., the metacarpal bones in a straight line with the forearm, is not in the proper position for convenience of gripping or for strength of gripping. The ideal position of function, therefore, lies between 25 and 30 degrees' extension (Fig. 8). I like to remember this by the simple procedure of "making a fist." As the fingers are flexed into the palm, the wrist automatically goes into the proper amount of extension to furnish maximum strength, function, and cosmetic appearance.

I would like to add another "position of function" to that of hyperextension as described by Kanavel and others. It seems to me to be very important, yet I can find no description of it in the literature. I refer to "neutral lateral position" of the hand (Figs. 8 and 9). This means that the hand should not be deviated to either the ulnar or the radial side but should be straight forward on the forearm. For some reason most students of surgery believe that all wrists and hands, when immobilized, should be put up in varying amounts of ulnar deviation. It is held by some that such is the normal anatomical position. If one should believe that the latter is true, let one make a grip with the hand held in ulnar deviation and note how weak the first three fingers are. However, if the hand is held loosely and the fingers firmly flexed into the palm, one will find that the hand assumes neither ulnar nor radial deviation but is straight forward on the forearm in neutral lateral position. This position is demonstrated also by "making a fist." Another way to accomplish the position is to flex the middle finger into the palm, and whenever the hand is straight on the forearm the flexed middle finger will point up the forearm. From the dorsal aspect the hand is in neutral lateral position when the middle finger is in line with the middle of the forearm.

Besides strength, there are other reasons why the hand should be immobilized in neutral lateral position. These are writing, awkwardness, and appearance, and they can be described best by giving actual cases. One patient was a stenographer whose wrist was fused in ulnar deviation. She suffered great fatigue, numbness, and pain along the hypothenar eminence and fifth finger when writing, because her hand was tilted and could not rest smoothly upon the desk. Another patient whose wrist was fused in ulnar deviation was a man who complained of awkwardness in work as well as in the performance of small acts. The hand being off center made it difficult for him to be accurate in picking up small articles and in grasping. As for appearance, a third patient denied symptoms from the ulnar deviation but admitted embarrassment because it was this deformity alone that attracted attention to her wrist. An example of a wrist fused in ulnar deviation is seen in Figure 6.

In summary, there are two factors in position of function of the wrist: (1) 25 to 30 degrees' extension; (2) neutral lateral position.

Gross pathological findings. Operative findings vary greatly and, of course, every tuberculous wrist does not present the same picture. In every case except 7 the disease appeared to have originated at the lower extremity of the radius. In 5 of the 7 cases the disease was diffuse, and its source could not be ascertained. In the sixth case the ulnar head was chiefly involved, presenting a cavity one-fourth inch in diameter filled with caseous material. The seventh case presented a definite cavity in the greater multangular bone while the navicular and radius were negative.

The distal end of the radius at times is intact but generally it presents an abscess cavity of varying size, sufficient often to destroy the entire distal end and extend proximally up the shaft. These cavities contain in some instances as much as 2 ounces of either caseous material, typical tuberculous pus, or yellow pus of varying consistency. When pus is present, it generally is localized to the radionavicular region, but at times it extends between the two rows of bones, even to the capitate and second and third metacarpal bones.

The synovial membrane is pale and gray, occasionally gray-red from inflammation. It is thick, boggy, or edematous, and generally of soft

TABLE II.—END-RESULTS AS TO CURE FROM SURGICAL FUSION OF THE WRIST FOR TUBERCULOSIS

Result	Cases
Solid fusions following first operation	8
Solid fusions following second operation	3
Solid fusions following third operation	1
Solid fusion with resection of ulnar epiphysis later	1
Refusal to have repair of pseudarthrosis	3
Amputation (1 died of pulmonary tuberculosis)	2
Death (carcinoma and pulmonary tuberculosis)	2
Unknown (moved away)	3

or gelatinous consistency. Often the entire carpus is covered with pale, purple-gray, tuberculous appearing, granulation tissue which at times bulges out upon incision of the capsule.

The cartilage is either eroded, atrophic, thin, friable, or absent. Sometimes it is loose and can be stripped away easily or even picked out with forceps alone. The resistant quality of articular cartilage was again demonstrated in one instance in which the entire proximal row of bones was destroyed, but a large cavity in the radius was discovered only after the radial cartilage had been removed. Several cases also revealed cartilage lying free although an entire row of bones was absent. In one case the styloid process of the ulna was separated.

The involved joints are always thin and narrow and very little passive motion can be elicited, particularly when disease is present throughout the carpus. The bones are very soft, decalcified, and atrophic, often being one-half normal size, distorted, and misshapen. When deep cavities or extreme decalcification are present the bones may be macerated or mashed together after removal of the cartilage. Sequestra occasionally are present. The proximal row of bones is generally diseased and at times entirely destroyed except for the pisiform which is rarely involved. The distal carpal row may be normal and often the carpometacarpal joints are not involved. In cases of long duration it is not uncommon to find natural fusion between the navicular, greater and lesser multangular bones. In one case all the carpal bones except the lunate were completely fused together and to the radius. In no case in this series was the first carpometacarpal joint involved.

When tendon and synovial sheaths are diseased, marked swelling is present due to edematous and gelatinous synovial lining. This occurred 3 times in 23 cases.

Proof of diagnosis. Tuberculosis should always be proved either by frozen tissue section, permanent tissue section, or guinea pig inoculation. Every case in this series was so proved. Although one patient died of carcinoma of the throat 15 months after wrist fusion, check up of the original sections of the wrist tissues revealed them to be typical of tuberculosis. In one case no typical tuberculous areas were seen upon inspection at operation but frozen section examination of the tissues was positive for tuberculosis. In another, the smear of pus from the wrist was positive for tuberculosis.

In the 13 cases in which it was done the Mantoux test was positive. The Wassermann test was negative in each case except one, but in this exception the frozen section and guinea pig diagnoses were positive for tuberculosis.

Sinus formation. Before operation sinuses were not present in any of the 23 cases. Following operation sinus formation occurred 7 times. Three healed within 6 to 8 weeks. Another remained open until refusion of the wrist was performed 6 months later. Two continued to drain until the hands were amputated at 9 and 12 months, respectively. Another drained until the patient died 15 months after operation.

Postoperative treatment. Two weeks after operation, if there are no complications, the sutures are removed; a snug, well fitting, plaster cast is applied; and the patient is discharged from the hospital. The plaster cast is worn from 12 weeks to 6 months depending upon the progress of the fusion. The period of immobilization averages about 3 to 4 months. After removal of the cast a sling is worn temporarily and gentle massage, hot soaks, light elbow and finger exercises, are given.

End-results. For purposes of clarity the end-results are classified in two different ways. (1) As to cure of the disease. This is the most important classification because the primary purpose in the treatment is to cure the local tuberculous lesion. It is well known that a complete and solid fusion, be it by surgical or natural means, does produce a cure. (2) As to anatomical, symptomatic, and functional results. In this classification, which is the most comprehensive, not only is the state of fusion considered in regard to the presence or the absence of a cure, but symptoms and function are also discussed and evaluated upon a numerical basis.

The end-results are based upon a follow-up period ranging from 1 to 13 years, except for 2 cases of 6 and 9 months each. The 3 patients who disappeared and the 3 who died are not included in these figures. This leaves an average follow-up period of 3.6 years.

1. *Results as to cure* (*Table II*). It can be said definitely that 12 of the 23 patients were cured. It is not known why fusion cures tuberculosis, but

Fig. 10.

Fig. 10. Fracture-dislocation of wrist. Anteroposterior views before and after operation. Note restoration of alinement after proximal row of bones has been removed and head of capitate bone has been buried in end of radius.

Fig. 11.

Fig. 11. Volkmann's paralysis following fracture. Lateral roentgenograms. In left print note the degree of flexion deformity before operation and in right print the degree of extension after operation.

observation shows that once a tuberculous joint becomes completely solid, with the disease subsided, disease does not recur in that joint. Eight fusions became solid following the first operation, and judged roentgenographically, fusion in these cases occurred: at 3 months in 2 cases; at 6 months in 2 cases; at 7 months in 1 case; at 9 months in 1 case; and at 12 months in 2 cases. Three additional fusions became solid after a second operation and 1 after a third operation.

Another case showed fusion of the radiocarpal joint at 9 months but the ulnar head became involved and had to be resected. At the time of resection, the radiocarpal joint was found to be solid. Since tuberculosis does not spread from a solid fusion area, the ulnar head must have become infected in the manner previously described, during the period the wrist was undergoing fusion.

Eleven patients developed pseudarthroses. Four of these obtained a solid fusion, as stated. Three patients refused to have the pseudarthrosis repaired. One patient with a pseudarthrosis died of carcinoma of the throat 15 months after wrist fusion had been attempted, and another died 3 months after operation from active pulmonary tuberculosis which was present before operation. Amputation was performed in the 2 remaining cases. The latter were white males, aged 58 and 69, who gave a history that 18 and 9 months earlier they had fallen and injured the right and left wrist, respectively. Both had been treated elsewhere by hot applications and massage. At operation pus was present in each wrist and by guinea pig inoculation the tissues were positive for tuberculosis. Sinuses formed, fusion did not take place, and the wrists and hands became useless from extensive disease. Twelve and 9 months after attempted wrist fusion, amputation at the lower fourth of the forearm was performed. One patient died 3 months later of pulmonary tuberculosis which had been present over 2 years. The older man lived.

2. *Results as to anatomy, symptoms, and function.* The 23 cases were graded on the basis of 4-4-4 for perfect anatomical, symptomatic, and functional results. In discussing Table III inversely, 3 patients moved to Colorado, Italy, and Japan, soon after operation was performed and end-results remained unknown.

Failures occurred in 4 cases through amputation or death. These were discussed previously.

TABLE III.—END-RESULTS AS TO ANATOMY, SYMPTOMS, AND FUNCTION, OF SURGICAL FUSION OF THE WRIST FOR TUBERCULOSIS

Result		Cases
Perfect	(4-4-4)	4
Good	(3-3-3 to 4-4-4)	8
Fair	(3-3-2)	1
Poor	(1-2-2, 1-3-2, and 0-1-2)	3
Failure (amputation, death, or both)		4
Unknown (moved away)		3

Fig. 12.

Fig. 12. Spastic paralysis affecting wrist before operation. Note flexion of fingers in anteroposterior view and of wrist in lateral view.

Fig. 13.

Fig. 13. Same case after operation. Note extension of fingers in anteroposterior view and of wrist in lateral view after removal of proximal row of bones and fusion of wrist.

In the 3 results rated as poor the fusions were incomplete but the disease was quiescent. The patients were greatly improved and had returned to their vocations of housewife, nurse, and waitress, which they previously had had to give up and which they now accomplished satisfactorily except for fatigue and aching at night after a day's hard work.

A fair result (3-3-2) occurred in 1 case. The disease was cured but because the wrist became solid in slight ulnar deviation instead of neutral lateral position and in 10 degrees' extension rather than 25 to 30 degrees' extension, only an anatomic 3 was given. The patient returned to his old occupation as cabinet maker but because his efficiency was not as great as formerly and because he lacked complete flexion of the fingers, although extension was good, a functional 2 was allotted. With light work he suffered no symptoms, but after heavy work temporary stiffness of the fingers occurred; also slight twinges of pain were present with changes in weather, so a symptomatic 3 was given.

Good results were obtained in 8 patients, the grading being from 3-3-3 to 4-4-4 as follows: three 4-4-3's; two 4-3-4's; and one 3-3-4, 3-4-4, and 4-3-3. The joint became solid and a cure was obtained in each case. A 3 instead of a 4 was given, however, because of such conditions as inability to make a tight fist, occasional pain in bad weather, and slight adduction deformity of the hand.

Perfect results (4-4-4) occurred in 4 cases. Such rating indicates that a cure of the local lesion was obtained with the wrist solidly fused in excellent position, that no limitation of function of the hand and forearm was present, and that the patient was symptom free.

Conservative treatment. For comparative purposes a study was made of all the records from 1905 to 1933 of patients with tuberculosis of the wrist who had been treated conservatively and without operative interference. There were 52 such records. The range of age was from 2 years to 60 years. There were 12 more males than females but the site of affliction was practically equally divided between right and left. Diagnosis of tuberculosis was made by the history, examination, roentgenograms, aspiration, biopsy in 1 case, sinus formation, and the course of the disease. Treatment consisted of immobilizing procedures such as strapping, casts, and braces. The follow-up period ranged from 3 months to 18 years with an average of 3.9 years.

Only 8 of the 52 patients were relieved of their symptoms and 1 of these continued to have intermittent pain after wearing a brace for 2 years. Sinuses were frequent, some draining for as long as 2 years. Braces were worn in each case. It is important to note that as the wrists became asymptomatic motion also became markedly limited.

None of the 44 remaining patients was relieved. Many were discouraged. Twenty-seven sought treatment elsewhere. After wearing a brace 9 years, 1 patient still suffered pain and spasm of the wrist and hand. Four died. One of these developed tuberculosis of the knee 3 months after

the onset of the disease at the wrist and died of pulmonary tuberculosis 18 years later, still wearing a brace. Amputation was necessary for 1 patient. Another developed tuberculosis between the tenth and twelfth thoracic vertebræ 3 years after involvement of the wrist. The foot and spine became affected in another case. Active pulmonary tuberculosis was diagnosed in 3, and no doubt existed in many more.

On the other hand 2 patients developed tuberculosis of the wrist from other foci. One of these had had a draining tuberculous hip and shoulder for 10 years before the wrist became diseased, and finally died 2 years later of tuberculous meningitis. The other had a draining tuberculous sacroiliac joint for 5 months before the wrist became affected, and this was followed by tuberculosis of the knee.

Table IV allows comparison of the results obtained from operative and conservative treatment of tuberculosis of the wrist.

TABLE IV.—COMPARISON OF END-RESULTS IN THE OPERATIVE AND CONSERVATIVE TREATMENT OF TUBERCULOSIS OF THE WRIST

	Operative		Conservative	
Average length of follow-up	3.6 years		3.9 years	
Number of patients treated	23		52	
Number disappeared	3		27	
Total remaining for follow-up study	20		25	
	Cases	Per cent	Cases	Per cent
Cured	12	60	0	0
Relieved	4	20	8	32
Not cured	4	20	17	68

CONDITIONS OTHER THAN TUBERCULOSIS OF THE WRIST

Fusion of the wrist was performed upon 21 patients suffering from rheumatoid arthritis, obstetrical paralysis, poliomyelitis, fracture-dislocation, Volkmann's paralysis, gonorrheal arthritis, and spastic paralysis. The cases under each condition will be given in detail. The method of fusion follows the same general principles as were discussed under tuberculosis. Variations of importance, however, are mentioned below.

When adduction deformity of the hand is severe it is necessary, in order to obtain correction, to remove wedges of bone from the lateral aspect of the radius and navicular bones. In addition, lengthening of the flexor carpi ulnaris tendon may be necessary also before the hand can be placed in neutral lateral position.

When flexion deformity of the hand is present or the fingers are contracted, it is wise to remove the proximal row of carpal bones, i.e., navicular, lunate, and triquetral. The flexion deformity of the hand thus can be overcome easily. At the same time, this will give more motion to the fingers or will allow them to retain the same amount of motion after the wrist is extended as was present in flexion. If the flexion deformity and contracture of the fingers is severe, stretching by the Jones splint should be carried out before operation, and after operation the fingers should be held hyperextended as much as possible.

When tendon sheaths have been destroyed, plastic implantation of adipose tissue may aid materially in improving finger function by preventing adhesions between the bare bone and the bare tendons.

When bone circulation appears to be poor, as it is in hard, eburnated bone, fusion may be aided by placing drill holes in the distal end of the radius and surrounding carpal bones.

Fusion is also encouraged by establishing a stable fusion area. This can be done best at the wrist, in those cases in which it is necessary to remove the proximal row of bones, by cutting a recess into the radius to admit snugly the denuded head of the capitate bone. Such can be performed with impunity when the distal radial epiphyseal line is closed but with care otherwise. When the radial epiphysis is too small to allow for the carrying out of such a procedure, the head of the capitate is removed in order to approximate the carpal bones and radius.

RHEUMATOID ARTHRITIS

Rheumatoid arthritis of the wrist is a very incapacitating condition producing a swollen joint that is painful and weak, allowing little use of the hand. In selected cases in which the joint has become so disorganized that it is not amenable to conservative treatment, elimination of pain and restoration of function to the hand may be accomplished by wrist fusion.

Four patients, 3 females and 1 male, ranging in age from 17 to 37 years, were so treated. Symptoms had been present from 2 to 9 years except for 1 acute case of 2 months' duration. All had received the usual anti-arthritic treatment of heat, massage, exercises, salicylates, supports, x-rays, and attention to foci of infection. Examination revealed warm, red, swollen joints with severe spasm and pain upon attempted motion. Anteroposterior motion was only 10 to 20 degrees associated with full pronation, limited supination, and absent lateral motion. The roentgenograms showed decalcification, thinning of the cartilage spaces, and effusion.

The presence of the above findings caused 3 of the 4 patients to be observed for tuberculosis before it was ruled out. Cultures and Wassermann reactions were likewise negative. But fusion was done because of the pathological findings of thick, gray, edematous synovial membrane, thin cartilage that separated easily, and soft bones showing areas of erosion. Occasionally fibrous tissue was found between the bones, and in the acute case of only 2 months' duration, the presence of seropurulent fluid and a small amount of caseous material caused the surgeon to make a macroscopic diagnosis of tuberculosis but careful microscopic examination of the tissue did not prove this. The complement-fixation test for gonococcus was also negative in this case.

The operations were carried out in the routine manner by removing the cartilage from all bones, except the pisiform and the greater multangular, and placing bone chips in the intercarpal spaces.

In one case the sheaths of the extensor tendons had become thickened and edematous, with destruction of the anterior portions. As is well known, adherent tendons with resultant impaired finger motion are a serious handicap. Therefore, a layer of fat was taken from the thigh and transplanted over the bone in order to prevent adhesions between the bare bone and overlying tendons through the destroyed anterior portion of the tendon sheaths. Active finger motion was started on the fourth day after operation and in 6 weeks motion of the fingers was complete. Five and one-half years later a perfect functional result was still present; furthermore, this was the only one of the 4 cases that did have a perfect end-result.

In all 4 cases healing of the incision was *per primam* without sinus formation. Plaster casts were worn from 3 to 5 months and the fusions became solid within 3 to 6 months.

Grading on the basis of 4-4-4 for perfect anatomical, symptomatic, and functional results, in the order named, the results were: 4-4-4, 4-4-3, 4-4-2, and 2-4-3. These end-results were in turn based upon a follow-up period ranging from 5½ to 12 years, with an average of 8 years.

Three of the 4 wrists became solid in proper position and received an anatomical 4. But a 2 was given in the other case because the wrist became solid in ulnar deviation rather than neutral lateral position and because rotation was limited.

Each case received a symptomatic 4 because each patient became free of all wrist symptoms. Heavy use of the hand was no longer painful. One patient stated that now he could drive a taxi all day without pain or fatigue. One woman was well pleased because she could not sew or pick up objects before operation while afterward she accomplished such with ease. Ironing also became a painless task.

The greatest mark down came in the functional group. Arthritis of the fingers limited finger motion and lessened the grip in 3 cases. Although such was present before operation a perfect funtional result was not given.

OBSTETRICAL PARALYSIS

The lower arm type of obstetrical paralysis (Klumpke's) offers the best results from wrist fusion because in spite of the drop hand, the shoulders and elbow muscles are adequate. The operation can also be of value in the whole arm type of paralysis, but here the musculature of the entire extremity is generally so poor that nothing better than a cosmetic result can be expected. The upper arm type (Erb's) does not give a drop hand thus allowing no indication for wrist fusion.

A 16 year old boy suffered paralysis of the left upper extremity at birth. Treatment elsewhere consisted of electrical stimulation, massage, and transplantation of the wrist flexors to the dorsum of the hand without resultant improvement.

Examination of the musculature of the left upper extremity revealed good power in the flexor and adductor muscles at the shoulder while the remaining shoulder muscles were poor in power. Elbow musculature was good except for fair pronator and supinator muscles. At the wrist the flexors were fair and the extensors poor while the fingers showed good flexor and fair extensor power. The wrist was held in 30 degrees' adduction and flexion, and no active extension was possible.

At operation the cartilage was removed from the radius, navicular, and lunate bones. A wedge of bone also was removed laterally in an attempt to correct the ulnar deviation. The fusion became solid in 4 months and the plaster cast was removed.

Four years, 8 months later the patient was rated as a 2-4-4 result. An anatomical 2 was given because although the wrist had become solid in extension a 20 degree adduction deformity persisted which the patient did not like for cosmetic reasons. In addition, rotation was limited to 75 degrees' pronation and 45 degrees' supination.

A symptomatic 4 was given because there were no symptoms, even in bad weather.

Excellent function gave a functional 4 result. The patient stated that the operation was of great value and had given more strength to the entire arm. The grip was now almost equal to that of the normal side. Formerly the tighter he grasped, the more flexion occurred at the wrist, with a corresponding weakness of grip. Now with the hand extended the grip was more certain, stronger, and of greater duration. For the first time he could button his shirt and dress himself with this hand.

POLIOMYELITIS

Wrist fusion in poliomyelitis is of value not only in the classical case of good flexor and absent

extensor muscles, but also in combination with shoulder fusion when the extremity is practically flail. It may also be used for cosmetic purposes when the hand is flail, useless, and dangling at the side in poor position.

The ages of the 2 girls and 1 boy so treated varied from 12 to 19 years, and they had not had full use of the affected upper extremity for 10 to 18 years.

One had good musculature at the shoulder and elbow but no power at the wrist and hand except for poor flexors of the fingers, resulting in the hand being held in 70 degrees of flexion and 60 degrees of pronation. After operation upon the wrist, at which time the first row of bones (navicular, lunate, and triquetral) was removed and the radius fused to the capitate and lesser multangular bones, the fusion became solid with the hand in extension and neutral lateral position; there were no symptoms except slight pain in the last 10 degrees of passive extension to 180 degrees due to the fingers remaining somewhat contracted as they were before operation; and the patient was able to drive a car for the first time in his 19 years of life. A grading of 4-3-3, based on a 3 year 3 month follow-up, was given this case.

Another had a flail shoulder and elbow with fair flexors and poor extensors at the wrist in addition to poor power in the fingers. Due to fair adductors and absent abductors the wrist presented an adduction deformity. To correct this the flexor carpi ulnaris tendon was lengthened and a wedge of bone was removed from the navicular and radius. Fusion was carried out by removing the cartilage from the first and second row of bones. Three months later the wrist was solid. Two years and 2 months afterward there were no symptoms. Cosmetically the hand was improved by the better position and for this a 1 was given. Otherwise the hand was no more useful than before. Fusion in good position, without symptoms, and with the hand cosmetically improved, gave a rating of 4-4-1.

The third case presented a flail shoulder and wrist with good musculature at the elbow. The child was 12 years old and fusion of the shoulder and the wrist were performed at the same time, the wrist by macerating the carpal bones, end of the radius, and bases of the metacarpals, after their cartilages were removed. The result 9 years 4 months later was a solid wrist and shoulder, with the wrist at 180 degrees and in 5 degrees of adduction instead of 30 degrees' extension and neutral lateral position, for which an anatomical 3 was given. There were no symptoms—a symptomatic 4. Functionally, the patient could now hold a knife and fork, typewrite, dress herself, and open doors—things she could not do before operation. A firm grasp was present due to good flexor muscles functioning against a fused wrist. The patient herself was well pleased. This was a very good result considering the extensive paralysis, and a functional 3 was granted, making the rating 3-4-3.

FRACTURE-DISLOCATION

For injuries that completely disrupt the continuity of the wrist, allowing no recourse to open or closed reduction, fusion offers the quickest, most effective, and permanent relief.

In one case a 44 year old man fell 35 feet receiving a fracture-dislocation of the left wrist (Fig. 10) in addition to fractures of the left tibia, second lumbar vertebra, and right radius.

At operation the proximal row of carpal bones (navicular, lunate, and triquetral) was removed. The cartilage was removed from the radius, capitate, and hamate bones. A recess was cut into the radius to admit the denuded head of the capitate bone which was sutured to the radius.

The result 3 years 4 months later was 4-4-4 with the fusion solid in good position; with no pain or other symptoms; and with good function without disability.

Another case was that of a longshoreman who fell from a similar height and received a fracture of the radius which united with shortening and overlapping of the fragments, causing a 30 degree abduction deformity of the hand. Function and strength were so poor that the patient had to give up work. At the time of wrist fusion drill holes were placed in the radius and surrounding carpal bones for stimulation of circulation. The follow-up 4 years 10 months later revealed fusion between the radius and lunate but none between the radius and navicular bones, and motion was from 15 degrees' flexion to 25 degrees' extension. For lack of fusion a zero was given. Symptomatically, however, the patient received a 4 because there was no pain, spasm, tenderness, or swelling, even in bad weather. A 4 also was given for function. There was good musculature and circulation. Finger motion was complete and strong, with the grip being almost equal to the normal side. He returned to work as a longshoreman upon removal of the cast 3 months after operation and stated nearly 5 years later that he could do any work anyone else could. He was very well pleased. The rating given was 0-4-4.

VOLKMANN'S PARALYSIS

Volkmann's paralysis (Fig. 11) offers a poorer prognosis than any of the conditions for which wrist fusion may be done because the shiny, stiff, board-like extremity is generally beyond functional improvement. However, the patient can be improved cosmetically when flexion deformity is present by fusing the wrist with the hand in good position.

Such was done for 2 patients who had suffered Volkmann's paralysis 1 and 14 years earlier. Both had flexion deformities of the right hand of 25 and 60 degrees, respectively, with only 20 degrees of anteroposterior motion. The flexion deformity had been wedged out by plaster casts and a brace worn, but each time the deformity recurred upon removal of the brace.

At operation the proximal row of bones (navicular, lunate, and triquetral) was removed in an attempt to relax the flexor tendons and overcome their contracture. Though this did not improve the function of the fingers in 1 case it kept them from contracting further because with the hand solid in extension there was as much finger motion as there had been before operation. Grasping in both cases was carried out with the fingers, which moved one-third of normal, and the strong, freely movable thumb. Both patients were pleased and at ease with a stiff wrist in extension rather than with the former one in flexion. One was free of all symptoms while the other continued to be sensitive to burns due to the previously impaired sensation.

Ratings of 2-2-2 and 2-4-0 were given on a follow-up basis of 4 years, and 1 year 5 months.

GONORRHEAL ARTHRITIS

Gonorrheal arthritis rapidly produces fibrous or bony ankylosis at the wrist and if, during the

activity of the disease, the hand is placed in proper position there need be no reason later for wrist fusion. However, when such wrists become ankylosed in poor position they must be corrected. In this case the 30 degree flexion deformity did not allow the patient to flex the fingers completely. She also suffered pain in bad weather and upon lifting.

At operation there were 10 degrees of motion at the radionavicular joint while the remaining carpus was a solid mass of hard and eburnated bone. Chips from the mass were taken to fuse the radionavicular joint. The wrist became solid within 3 months in 15 degrees' extension. Because 30 degrees' extension would have been better, an anatomical 3 was given. There was no swelling, pain, tenderness, or spasm, but because of an occasional numbness of the fingers and stiffness after washing clothes, a symptomatic 3 was given. Due to 75 degrees of supination instead of 90, and a grasp weaker than the normal side, a functional 3 was given.

These findings, based on a 3 year 8 month follow-up study, gave a 3-3-3 result.

SPASTIC PARALYSIS

Wrist fusion offers much for the unfortunate victim of spastic paralysis (Figs. 12 and 13). The usual deformity of a flexed hand which the patient generally is unable to extend actively, associated with hyperextension or hyperflexion of the fingers, is a well known condition. In the mild cases, fusion improves function by placing the hand in extension allowing better strength and motion of the fingers. In the severe cases, the spasticity prevents good finger function, but cosmetically the bad position is overcome by fusion, which in turn eases the patient's embarrassment and improves the morale. In a sense, also, function of the extremity is improved in that it is much easier to put the straight hand through a coat sleeve or in a pocket than when the hand is in severe flexion.

Eight patients of both sexes ranging in ages from 13 to 25 years, and suffering the deformity the same length of time, received wrist fusions for deformity resulting from spastic paralysis. Each patient complained of inability to extend the hand completely; lack of strength due to the flexion deformity; inability to eat, write, and lace shoes; and failure of precision in handling small objects.

All had been under treatment at this hospital from 4 to 19 years receiving exercises, massage, and braces. Previous operations included transplantation of the flexor carpi ulnaris and radialis to the extensors of the fingers, and cervical ramisection.

The deformity varies according to the patient but generally the elbow is flexed, the forearm pronated 90 degrees, the wrist flexed 45 degrees and adducted 45 degrees, and the fingers extended, except for the thumb which is held adducted. Most of the patients can open their hands in flexion but in this position the grip is always poor. Others have full range of finger motion but fine movements are labored, inco-ordinate, and uncertain. Rarely is there free motion of the elbow and shoulder but when such is present, the functional result of the hand after operation is much better.

The operating time varied from 39 minutes to an hour and one-half. In 5 of the 8 cases, the proximal row of bones was removed in order to accommodate the shortened flexors of the fingers. Such was not done in the 3 other cases because good finger motion was present before operation.

When the navicular, lunate, and triquetral bones are removed, the cartilage is excised from the distal end of the radius; proximal and lateral aspects of the lesser multangular; proximal, medial, and lateral aspects of the capitate; and proximal and medial aspects of the hamate bones. A cavity is then made in the radial articular process, care being taken not to injure the epiphyseal line if it is not closed, and the head of the capitate is snugly buried in the radius. Small bone chips from the radius are placed where necessary. A long arm cast with the wrist in 25 to 30 degrees' extension and neutral lateral position, and the fingers in 45 degrees' extension in order to stretch the flexor muscles, is applied. The cast should extend to the finger tips and because the thumb generally presents an adduction deformity it should also be encased in plaster and held widely abducted.

Casts were worn from 2 to 4 months. Those worn the shortest period of time showed less finger motion due to the rapid contracture of the fingers, indicating that holding the finger flexors stretched for a longer period of time improves finger function. For this reason most casts now are left on for a period of 16 weeks. After removal of the cast, hot soaks, massage, and a sling, are given for the wrist plus light exercises for the elbow and the fingers.

All fusions became solid within 2 to 4 months, except for 1 case which developed a pseudarthrosis.

One patient was omitted from the end-result study because she ignored requests to return for observation. The roentgenogram 2 months after operation revealed fusion to be present but because a longer follow-up could not be obtained, the case was eliminated from this series. The average follow-up period for the 7 remaining cases was 1 year 2 months.

A complete failure (0-0-0) was the end-result in 1 case. A 90 degree flexion deformity of the hand, with the flexor muscles of the fingers tight and spastic, was present before operation. After operation the radius became fused to the navicular and lunate bones but after removal of the cast, motion was present between the 2 rows of bones, and between the distal row and metacarpal bones. Soon, therefore, the pull of the tight finger flexor muscles caused the hand to assume the position of 35 degrees' flexion. Although this was better than 90 degrees' flexion, it was insufficient to improve function or appearance. If the proximal row of bones had been removed in order to accommodate the short, spastic, flexor tendons, and if the carpometacarpal joints had been fused along with the radiocarpal joint, a different result might have been obtained. For lack of a complete fusion an anatomical zero was given. Following operation passive motion was painful, so a symptomatic zero was given. A functional zero was also allotted because the hand was neither more useful nor better in appearance than before operation.

Fair results (4-4-1, 4-4-1, 3-3-1) were obtained in 3 cases. Solid fusion in good position, without symptoms, occurred in 2 cases for an anatomical and symptomatic 4, while fusion in slight ulnar deviation plus the presence of slight pain, reduced the rating to a 3 in the other case. Functionally, none of the patients gained much finger motion in spite of the removal of the proximal row of carpal bones, and the fingers remained spastic and uncontrollable. However, there was improvement in the appearance of the hand

TABLE V.—SUMMARY OF END-RESULTS IN ALL CASES OF SURGICAL FUSION OF THE WRIST JOINT

Condition	Cases	Perfect	Good	Fair	Poor	Failure	Unknown
Tuberculosis	23	4	8	1	3	4	3
Rheumatoid arthritis	4	1	2	1			
Obstetrical paralysis	1		1				
Poliomyelitis	3		2	1			
Fracture-dislocation	2	1		1			
Volkmann's paralysis	2				2		
Gonorrheal arthritis	1		1				
Spastic paralysis	8	1	2	3		1	1
Total	44	7	16	7	5	5	4

and this pleased the patients very much. Because of the cosmetic improvement a grading of 1 was given.

Good results (3-4-3, 4-4-3) occurred twice. One patient (3-4-3) had developed a pseudarthrosis following wrist fusion 2 years earlier. A second fusion was done because of pain, weak grip, loss of active extension of the fingers, and poor appearance of the hand. The wrist became solid at 180 degrees instead of 205 to 210 degrees and an anatomical 3 was given. No longer was there any pain, a symptomatic 4. The grip was now strong, there was complete active extension and flexion of the fingers, and the appearance of the hand was no longer embarrassing because it was straight instead of flexed. The patient stated that the whole arm could be used better. Muscle power increased and there was improvement in voluntary function and control. A functional 3 was allotted.

The end-result of the other case (4-4-3) was equally as interesting because operation was agreed to for cosmetic reasons only. Fusion occurred in good position and there was no pain, an anatomical and symptomatic 4. Before operation the grip was quite weak and there was no finger motion except a few degrees' flexion. Eleven months after operation the grip was fair and there was complete active flexion of the fingers. Extension, though, remained limited. She could pick up objects more easily and stated that no longer was it necessary to use her good hand to assist the affected arm in putting on a dress or coat. Being a girl, she was extremely pleased that people no longer noticed the previously deformed hand. A functional 3 was granted.

A perfect end-result (4-4-4) occurred only once. The wrist became solid in proper extension and excellent lateral position. There were no symptoms. The grip was good. There was full range of active extension and flexion of the fingers. The patient stated that cosmetically the hand was very much better and that functionally the wrist and hand were at least twice as useful as before.

SUMMARY

1. Forty-four cases of surgical fusion of the wrist joint for tuberculosis, rheumatoid arthritis, obstetrical paralysis, poliomyelitis, fracture-dislocation, Volkmann's paralysis, gonorrheal arthritis, and spastic paralysis, are presented.

2. A theory as to the etiology of secondary tuberculous involvement of the ulnar epiphysis in tuberculosis of the wrist joint is offered.

3. Tourniquet, operative, and plaster techniques are discussed.

4. The operative and non-operative treatments of tuberculosis of the wrist joint are compared.

5. The proper functional position for a solid wrist joint is given.

6. End-results from an average follow-up period of 4.1 years are listed in detail.

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MACROCHEILIA DUE TO HYPERPLASIA OF THE LABIAL SALIVARY GLANDS; OPERATIVE CORRECTION

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MACROCHEILIA may be defined as an abnormal or excessive size of the lip. Under this heading the literature includes a number of conditions, either inflammatory or neoplastic in character. Abnormal enlargement of the lip, admittedly rare in occurrence, is given little emphasis in the standard references and texts of this day. One author (19) refers to macrocheilia as due to simple lymphangioma of the lip. Another (35) states that certain of the enlargements of the tongue and lip, known as macroglossia and macrocheilia, are undoubtedly lymphangiomatous in nature. In a third text (5) it is noted that only in recent years have many examples of an exaggerated appearance of the labial glands throughout the mouth been seen. The histories of cases reported in the literature often give such meager accounts of the clinical and pathological data pertaining to the condition that accurate classification of reported cases is not possible. My recent experience with 3 cases of macrocheilia of the upper lip in which pathological examination of tissue removed at operation showed the enlargement to be due to increase in the size and the number of labial salivary glands has led me to the conclusion that this condition is more common than formerly believed and that many cases of this type are erroneously diagnosed as lymphangiomas.

Macrocheilia, when associated with ulceration, usually may be diagnosed clinically. Syphilis, carcinoma, and tuberculosis of the lip may be differentiated by the well known characteristic signs of these pathological entities. In the absence of ulceration, however, the diagnosis is more difficult. Macrocheilia without ulceration may be due to simple hyperplasia of the submucous salivary glands, to lymphangioma or lymphangiectasis, to elephantiasis or to hemangioma. Of these, hemangiomas are easily differentiated by the compressibility of the swelling, its increase in size when the head is placed in the dependent position, the presence of varicosities beneath the surface of the skin or mucous membrane, and by the usually asymmetrical contour of the swelling. True elephantiasis of the lip may be ruled out by the characteristic appearance of its thickened and hypertrophic folds of skin and mucous membrane. Macrocheilia due to hyperplasia of the labial salivary glands is not easily differentiated clinically from lymphangioma in the same location. Both conditions present a diffuse enlargement of the lip, non-edematous, non-compressible, non-ulcerative. The etiology of both is obscure. To add to the diagnostic difficulty, perusal of the literature reveals that there also exists confusion in nomenclature. The term macrocheilia has been used to group a number of cases in which the reports give no data regarding histopathology but the lesion is presumed to be lymphangiomatous. Again, cases of simple hyperplasia of the labial glands are referred to as adenomas of the lip though no evidence of encapsulation of tumor tissue is present. Under the term double-lip, a few authors have reported cases with details of operative correction of the deformity but without complete data regarding histopathological examination of the tissue removed. In the German literature there are several records of cases of macrocheilia associated with blepharochalasis and enlargement of the thyroid gland. Referring to these as cases of Ascher's syndrome, subsequent authors attempted to set aside a new clinical entity. Records of similar cases do not appear in later years. Using the names, cheilitis glandularis apostematosa or myxadenitis labialis, Volkmann described as macrocheilia a lesion characterized by elevations representing muciparous glands with dilated follicular orifices which admitted a fine probe and from which mucoid, mucopurulent, or serous fluid could be expressed. A recent report by New and Kirch attempts to set aside a new clinical entity based on records of 67 cases of permanent enlargement of the lips and face secondary to recurring swellings and associated with facial paralysis. Their information on pathological examination of biopsy tissue is very meager. They state: "Specimens of tissue were taken for biopsy in a few cases before treatment, but nothing was found other than edematous tissue containing lymphocytes." Touraine and Solente have emphasized the precancerous nature of the condition which they designate cheilitis glandularis.

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One of the 3 cases which have been under my personal observation and treatment presented the "double lip" appearance as described in the German literature; this patient has developed mucous fistulas of the type described by Volkmann. Another exhibited recurrent swellings followed by permanent enlargement of the lip associated with facial paralysis as described by New and Kirch. Yet, all 3 have shown the same underlying pathological changes in the tissue of the enlarged lip, namely, hyperplasia of the labial salivary glands. In the case in which there was an associated paralysis of the facial nerve (Case 2), microscopy revealed, in addition, a diffuse inflammation of the submucous tissue. I have preferred to classify these 3 cases under the name "hyperplasia of the labial salivary glands" rather than under the older term "cheilitis glandularis," recognizing that the hyperplasia may occur either with or without evidence of inflammation.

LITERATURE

Bouisson in 1869 referred to tumors of the labial salivary glands and stated that, as yet, these conditions had not been subjected to numerous precise observations. In 1870, Volkmann gave the name cheilitis glandularis apostematosa or myxadenitis labialis to a syndrome which he had observed in 5 cases, 3 of which had syphilis. The lower lip was affected in all 5. In these cases, careful examination showed that the salivary glands of the lip had become "hempseed size," were swollen and were palpable as uneven masses in unusual number. Everting the mucosa of the lip outward one could see that the excretory ducts were so dilated that a probe could be inserted. By pressure, which caused only mild pain, an opaque, mucous or purulent secretion could be expressed. Wright in 1884 described a case in an 18 year old boy. Swelling of both lips had been present since birth. The glands were palpable beneath the intact mucosa. Successful removal was accomplished by a 2 stage operation. There was no evidence of infection. No microscopic examination was made. In 1892, Miles reported a case of enlargement of the upper lip in which, on gross examination, the labial glands were found to be hypertrophied. In the same year Fraenkel attached the name macrocheilia to an enlargement of the lower lip due to an adenomatous tumor of this region. Reproduction of the drawings of the gross specimen and the microscopic picture are shown in Figure 1. The gross specimen was described as a "pearl-like string of tumors." This patient was a youth of 19 years, and the swelling of the lower lip had been present since the age of 4 years. The lip was so enlarged that closure of the mouth was difficult. The patient was operated upon and a successful plastic result was achieved by Dr. Schede. A similar case was reported by Eisendrath in 1904. The patient, a 16 year old boy, had noticed swelling of the lips when 10 years old. Microscopic examination of the tissue removed showed "normal labial mucous gland substance." There was associated ptosis of both eyelids. In 1905, Lindenberger described the case of a man in whom the swelling followed a blow on the lip received 15 years earlier. Gross pathological examination revealed a number of small glands "slightly larger than buckshot." No microscopic examination was made. Donati in the same year described the same condition in a 20 year old man. The swelling in the upper lip had been present for 8 years. The excess tissue was excised and microscopy revealed that the overgrowth was due to enlarged mucous glands. Masera reported 2 cases in 1911. One occurred in a 24 year old woman; another in a youth of 19 years. Microscopic examination proved the tissue to be composed chiefly of numerous acinous labial glands with many excretory ducts. This author believed the macrocheilia of the upper lip to be due to hypertrophy and hyperplasia of the labial mucous glands. Roussel, in 1906, reported a case in which the lower lip had been swollen for 3 years. Mucous fistulas and luetic skin lesions were also present and no report of microscopic examination is given. In 1915, Stelwagon advanced the theory that the enlargement of the lip is due to adenoma of the mucous glands of the lips and is not due to syphilis. He based his conclusion on the clinical reports by Volkmann (5 cases), Sutton (3 cases), Fox (1 case), Schamberg (1 case), and Purdon (4 cases). In the year 1920, Ascher (1) described a case presenting the syndrome of blepharochalasis, struma and double-lip. Wirths (1920) reported a case with similar lid changes and double-lip without the enlargement of the thyroid gland. In 1921, Weve described as "syndrome Ascher" the case of a 27 year old healthy soldier who exhibited blepharochalasis and double lips, both present since the patient was 4 years of age. Later (1922) Ascher (2) described 2 additional cases of the same syndrome. One occurred in a 16 year old school girl; the other in a man of 39 years, who had swelling of the eyelids, double-lip, and painless swelling of both parotid glands. Ascher remarked that, in view of the rarity of blepharochalasis and as well the infrequent occurrence of double-lips, the simultaneous appearance of the two conditions in patients with severe struma was noteworthy. In 1920, Hatton described a case of

macrocheilia of the upper lip due to adenoma of the mucous glands. The patient was a man, aged 26 years. Microscopic section showed numerous mucous glands. Dorrance (1922) reported a case of double-lip present for 9 years in a patient 21 years of age. Gross examination of the specimen removed from the upper lip showed enlargement of the labial salivary glands. No microscopic report was given. In 1922, Roedelius described a case of macrocheilia of the lower lip with several small sinuses which admitted a probe and from which mucus was discharged. Roedelius' patient was a 45 year old man. The enlargement of the lip had been present since childhood. In infancy the patient had a plastic operation for harelip. Roedelius advanced the opinion that in patients with congenital harelip the protrusion of the lower lip might be a factor in exciting activity of the mucous glands thus leading to their overgrowth. In 1930, Meyer reported 2 cases, one a 10 year old school boy and another, a young woman of 23 years. The author commented on the marked abnormality in shape of the alveolar process of the upper jaw in both cases. The operative procedure used in these 2 cases follows. To reduce the enlarged lip to normal size 2 transverse elliptical incisions were made on either side of the midline. Another vertical elliptical incision was made in the midline. Wedgeshaped sections of tissue were removed from all 3 areas. Meyer chose to call the condition "ectropion of the lip" and stated that the histological examination in the 2 cases showed the membranes, the labial glands, and the surrounding tissues to be normal. Rosenstein, in 1932, reported a case of "Ascher's syndrome" in a 16 year old school girl. In this patient there was enlargement of both lips, a tendency toward hyperthyroidism, and enlargement of the eyelids. Because the enlargement of the lips developed at the onset of menstruation, Rosenstein believed the macrocheilia to be due to a disturbance of the endocrine glands. In 1933, Bejarano reported 2 cases of cheilitis glandularis in association with epithelioma. In both cases it was the lower lip which was involved. The authors admitted that it would be a grave error to generalize on cheilitis glandularis as a genetic factor in epithelioma of the lip. Touraine and Solente (1933–1935) described 2 cases and reviewed 41 cases from the literature. One of their cases was a lesion of the lower lip of 6 months' duration in a man 62 years of age. The second enlargement of the lower lip occurred in a woman of 60 years. The lesion was of a few months' duration. In the first case a small spindle cell epithelioma was found at the base of the infundibulum. Of the 41 cases in the literature which they reviewed 12 per cent showed malignant changes and were considered by them as precancerous. Eitner reported 9 cases in 1933. Of these, 3 showed enlargement of the eyelids in addition to the double lips but none exhibited signs of enlargement of the thyroid gland. The pathological examination is not reported. In 1933, New and Kirch presented 67 patients with localized swellings of the face. Regions involved by the swellings were as follows: upper lip, 38 cases; cheeks, 11 cases; lower lip, 9 cases; nose, 4 cases; eyelids, 3 cases; upper alveolar process, 2 cases. As already stated, in 13 per cent of these there was an associated facial paralysis. No reference is made by these authors to Ascher's reports and they do not comment on the concomitant swelling of eyelids and lips in the same patient. As stated before, the data regarding pathological examination are very meager in this report. Possibly many of the cases of macrocheilia in this series were due to hyperplasia of the labial salivary glands. Their treatment as outlined involved repeated injections of boiling water into the swollen area. After fibrosis occurred, the redundant tissue was removed by surgical excision. In discussion of the presentation of New and Kirch, Beck has given a meager account of 3 cases, 2 of which had a history of facial paralysis and Wilson briefly reported 4 cases of facial swelling, 1 of which involved the lips.

CASE REPORTS

CASE 1. J. S. (New York Hospital Case No. 128455.) In April, 1936, a 28 year old white man, a taxicab driver by occupation, presented himself at the plastic surgery clinic of the New York Hospital, with the chief complaint of swelling of the upper lip. He stated that without trauma or other antecedent cause he was startled on awakening one morning to find his upper lip, previously normal in size, swollen to huge proportions. He denied any fistic encounter. There was no injury. The swelling persisted for the 6 years prior to his admission to the clinic without marked variation in size. There was no facial paralysis at any time; no history of any allergic disease. Patient had received frequent treatments for chronic sinusitis of both antra during the previous 6 years. He had reported at several clinics in New York City asking for correction of the deformity of the lip. Each time treatment was deferred. At one institution complete allergic examination was done without significant findings.

Physical examination showed a diffuse enlargement of the entire upper lip so that it protruded in unsightly manner. Palpation of the lip revealed that the enlargement was not due to edema, and it was not compressible. There were no varicosities over either the cutaneous or mucous surfaces. No bruit could be heard. On digital pressure the swelling felt "shotty." Lowering of the head did not cause an increase in the size of the lip. Examination of the mucous membrane showed no ulceration, fissures, or fistulas. The tongue was not enlarged or furrowed. There

was no cervical adenopathy and the thyroid gland was not palpably enlarged. The mucous membranes of the rhinopharynx were hypertrophic, and both antra were cloudy on transillumination. The teeth were in good condition. Pre-operative photographs are shown in Figures 2 and 3. Blood count showed white blood cells, 11,300; hemoglobin 104 per cent.

On April 22, 1936, plastic excision of a large U-shaped wedge of hypertrophied labial tissue was done through an incision in the mucous side of the lip (Fig. 15).

Operation and result. At operation, the tissue was roughly nodular; cut section allowed for the bulging of minute yellowish nodules the size of a pin-head. The fibers of the orbicularis oris muscle were hypertrophied. Bleeding points were ligated with fine catgut and the edges of the wound were approximated with on-end mattress sutures of fine silk. Immediately after operation there was intense swelling of the upper lip. The postoperative edema continued for 6 days despite the constant application of compresses moistened with hypertonic saline and mouth irrigations with the same solution. From that time on the lip slowly decreased in size. Five weeks after operation it appeared approximately normal. The swelling has not recurred since operation was performed 20 months ago. Postoperative photographs are shown in Figures 4 and 5.

Pathology. Pathological examination was made by Dr. N. C. Foot. The specimen consisted of tissue removed from the lip. It measured 6 centimeters in length, 1 centimeter in thickness, and 1 centimeter in width. It was apparently composed of the normal constituents of the lip, but there were numerous node-like masses at the core within the layer of the muscle. There was no evidence of encapsulation. Microscopic examination of the specimen did not show any of the characteristics of lymphangioma. The size of the lip was increased mainly by excessive hyperplasia of the labial salivary glands. These were predominantly mucous in type although some serous cells were found. There was an apparent increase in fibrous tissue. Photomicrograph is shown in Figure 6.

Diagnosis. Macrocheilia due to hyperplasia of the submucous, labial, salivary glands.

CASE 2. B. L. (New York Hospital Case No. 169560.) This patient was a 28 year old Jewish housewife, mother of 2 children, who presented herself for treatment for the first time in May, 1937. A year before admission she awakened one morning to find her upper lip intensely swollen. There was no known related cause. The swelling increased for the next 2 months and then during a 4 month period decreased somewhat but the lip did not return to normal size. For 6 months prior to admission to the hospital, the patient had attacks of vertigo, chills, hot flashes, occurring at about 3 week intervals and always followed by an increase in the degree of swelling of the lip. In about 12 hours the swelling would reach its maximum and thereafter for 7 to 8 days it would decrease until the next cycle started. Menstruation ceased in 1936 following the birth of her last child.

Seven years before admission to the hospital and again 6 years before admission the patient described what apparently was a paralysis of the left side of the face, evidenced by inability to close the left eye or to use the facial muscles on both occasions. There was no history of idiosyncrasy to food or drugs. Patient had not used lipstick in 7 months. Several times leeches had been applied to the lip in unsuccessful efforts to reduce the swelling. The appearance of the patient before the onset of the deformity is shown in Figure 7.

When the patient was presented at the plastic surgery clinic of the New York Hospital, facial examination showed a diffuse swelling of the upper lip (Figs. 8 and 9). The enlargement caused ectropion of the mucous membrane and allowed the upper lip to protrude in unsightly fashion. The swelling was not compressible. There was no pitting of the skin and there were no varicosities over the surface of the lip. The lip was not tender. There was no bruit. Close inspection of the mucosa of the lip showed the presence of numerous submucous yellowish white nodules varying in size from 1 millimeter to 1 centimeter. The lip felt "shotty." Lowering of the head caused no increase in the swelling. Inspection of the mouth showed that the tongue was larger than normal and its surface presented the furrowed appearance of the geographic tongue. The teeth were in good condition. There was no evidence of disease of the paranasal sinuses. General physical examination revealed nothing remarkable. Blood count showed: white blood cells, 9,400; hemoglobin 104 per cent. Kline exclusion and Kline diagnostic tests were negative. Differential blood count: adult polymorphonuclears, 35 per cent; immature polymorphonuclears, 32 per cent; lymphocytes, 33 per cent.

Fig. 1. Reproduction of drawing of specimen and microscopic field from Fraenkel's case of macrocheilia due to "adenomatous tumor" of the labial salivary glands.

Operation and result. On May 25, 1937, the patient was operated upon under colonic ether anesthesia. The lip was

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 2. Case 1. Front view. Enlargement of upper lip of 6 years' duration. No variation in size of swelling. No trauma.

Fig. 3. Case 1. Pre-operative profile.
Fig. 4. Case 1. Postoperative front view.
Fig. 5. Case 1. Postoperative profile.

reduced to approximately normal size by the excision of a transversely placed elliptical wedge of mucous membrane, submucous glandular tissue, and adjacent hypertrophied musculature of the orbicularis oris muscle (Fig. 15). Profuse bleeding was controlled with ligatures of triple plain catgut. Edges of the wound were approximated with on-end mattress sutures of fine silk. Twenty-four hours after operation the patient had a violent chill and the temperature rose to 40 degrees C. (rectal). A blood culture taken at this time showed no growth. Over a period of 4 days the temperature dropped slowly to normal. It was a full month after operation before the postoperative edema subsided completely. The cosmetic result, as shown in Figures 10 and 11 was maintained for 6 months after operation. At that time the patient again experienced a mild chill, vertigo, and fever after which moderate swelling of the lip was again in evidence. A normal menstrual period followed (after an 18 month period of amenorrhea) and the lip returned to normal size. Two subsequent menstrual periods have occurred to date without recurrence of the symptoms or of the swelling of the lip.

Pathology. The microscopic section of tissue removed by biopsy preliminary to the plastic operation showed hypertrophied labial mucous glands which were increased in number. In addition there was evidence of acute inflammation. They showed no evidence of malignant change and were contained in a fibrous tissue stroma. Examination of the specimen removed at operation is described by Dr. N. C. Foot as follows: "Sections through the lip show a very marked hypertrophy of the mucous glands which are increased in number and show complete structure with ducts. Just beneath the mucosa there is a diffuse inflammation of the submucous tissue in which numerous tubercles are present with giant cells, epitheloid cells and lymphocytes. This has the appearance of a rather diffuse sarcoid. Tubercle bacillus stains show numerous diplococci and other bacteria but tubercle bacilli, as such, are not found. There are large numbers of mast cells. The lesion then, has some resemblance to that of lupus vulgaris engrafted upon the glandular hyperplasia already noted. Other sections show extensive inflammatory reactions probably secondary to biopsy." Photomicrograph is shown in Figure 12.

Diagnosis. Macrocheilia due to hypertrophy and hyperplasia of the labial salivary glands in association with non-specific cheilitis.

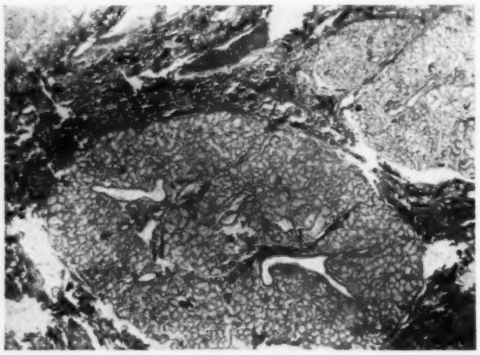

Fig. 6. Case 1. Low power photomicrograph of tissue removed from the lip. Normal structures were distorted by the presence of the hyperplastic labial salivary glands.

From the viewpoint of the clinician, these findings in microscopy in association with the unusual postoperative febrile reaction, the transient facial palsy (most probably inflammatory), and the intermittent increase in size of the swelling of the lip before operation gave evidence of the fact that in addition to the hypertrophy and hyperplasia of the labial salivary glands, there was also present some degree of non-specific cheilitis.

Case 3. M. I. (Case of Dr. W. DeW. Andrus.) A 33 year old white woman presented herself for correction of a deformity of the upper lip which had been noticed for the first time following an injury (fall down the stairs) sustained 25 years earlier. The enlargement had persisted without variation in size. There was no history of facial paralysis. In childhood the patient had measles, mumps, whooping cough, and chicken pox. There was no history of disease of the paranasal sinuses and no evidence of allergic disease. The history was otherwise irrelevant. Patient desired operative correction of deformity for its cosmetic effect.

Fig. 7.

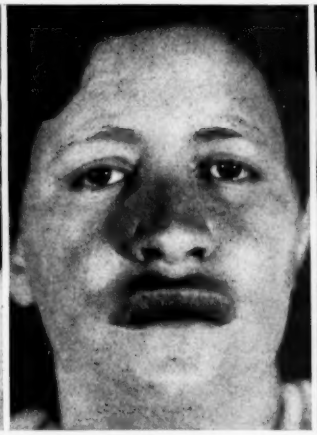

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 7. Case 2. Photograph of patient taken before the occurrence of the deforming enlargement of the upper lip.

Fig. 8. Case 2. Pre-operative front view showing the enlargement of the upper lip. The swelling increased periodically and on two occasions there was transient facial paralysis.

Fig. 9. Case 2. Pre-operative profile showing the excessive enlargement of the upper lip.

Fig. 10. Case 2. Postoperative front view showing the condition of the lip 6 months after plastic operation.

Fig. 11. Case 2. Postoperative profile taken 6 months after plastic operation.

Physical examination showed diffuse enlargement of the upper lip with a transverse furrow which was most pronounced when smiling or laughing. This conformed to the description in the German literature under the term "double-lip." There was indentation in the mucous membrane at the point of attachment of the frenum. Palpation of the lip revealed that the enlargement was not due to edema and it was not compressible. No varicosities were in evidence. No bruit could be heard over the swelling. Lowering of the head did not cause an increase in the size of the lip. On digital pressure the lip felt nodular. There were no ulcerations, fissures, or fistulas. Examination of the neck revealed no enlargement of the cervical glands or of the thyroid gland. There was no evidence of disease of the nasal sinuses and the teeth were in good condition. The remainder of the physical examination was negative. Laboratory data: white blood cells, 9,450; hemoglobin, 90 per cent; blood, Kline, negative; Wassermann, negative. Photograph of patient is shown in Figure 13.

Operation and result. On August 4, 1934, Dr. Andrus excised an elliptical segment of mucous membrane and underlying tissues approximately 3 by 1 centimeters in size from the right upper lip and a similar segment from the left upper lip. The wounds were closed with interrupted sutures of catgut. After operation there was moderate swelling of the lip. This receded to normal in 10 days.

Pathology. Gross examination of the specimen showed hyperplasia of the submucous tissue. There was no tendency toward encapsulation of the hyperplastic tissue. Microscopic examination showed excessive hypertrophy of the submucous salivary glands. These tended to arrange themselves in small nodules as shown in Figure 14. The cells were both serous and mucous in type. There was an increase in fibrous tissue.

Diagnosis: Macrocheilia due to hyperplasia of the submucous salivary glands with "double-lip" formation.

Three years later the patient reported for examination because of a recurrent swelling on the right side of the upper lip. In the interim there had been no swelling. Examination showed that a nodule 1 centimeter in diameter was present in the line of closure on the mucosal side of the lip. It was punctured and saliva exuded. A small fistula remained. Photograph of the patient at that time showed that a suggestion of "double-lip" formation was still present. At a second operation the excess labial tissue was excised. Microscopic examination of the tissue removed showed a picture similar to that described. The patient has remained well to the present date, 5 months after the second operation.

After a careful review of 129 cases of macrocheilia collected from the literature and a personal

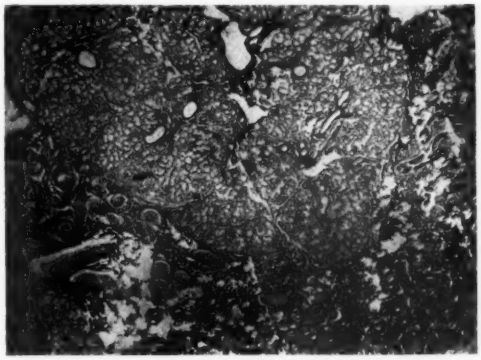

Fig. 12. Case 2. Low power photomicrograph. Tissue adjacent to hyperplastic labial salivary glands shows much evidence of chronic and subacute inflammation.

Fig. 13. Case 3. Front view showing the "double lip" formation of the upper lip apparent on laughing.

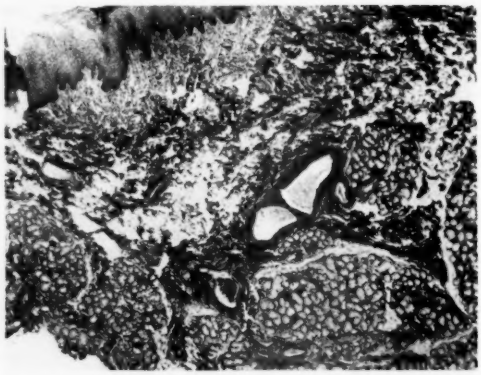

Fig. 14. Case 3. Low power photomicrograph of tissue removed from the upper lip at operation. Note the hypertrophy and hyperplasia of the labial salivary glands.

study of 3 additional cases, it is strikingly apparent that the etiological factor in this local alteration of the labial salivary glands has not been determined. Because the enlargement of the lip was present in some cases from early childhood, certain authors have held to the theory that the abnormal enlargement of the lip is congenital in origin. The underdevelopment of the upper jaw as a cause of over activity of the under lip with consequent stimulation of the mucous glands as observed by one author has been not regularly noted by others. The presence of mucous fistulas with associated infection (cheilitis) in certain cases has given rise to argument for the infectious nature of the disease. In none of these cases was the bacteriological examination adequate. Regarding specific infection, many of the later case records state that serological tests for syphilis were negative; in the earlier cases in which the patient exhibited clinical signs of syphilis at the same time that the lip was enlarged, there is no conclusive evidence that the macrocheilia was a manifestation of that disease. A few of the descriptions of cases associate the onset of the enlargement with an antecedent trauma. The vast majority, however, do not give a history of injury and the evidence, on the whole, is against previous trauma as a causal factor in hyperplasia of the submucous glands. That the hyperplastic condition of the labial salivary glands is not neoplastic in origin is favored by the fact that not one of the cases has shown true tumor formation although many of them have been recorded as adenomas. The formation of adenoma in the submucous glands of the lip appears improbable because of the rare occurrence of true adenomas in the major salivary glands, namely the parotid, the submaxillary, and the sublingual. The occasional reports of adenoma of these glands have always excited academic discussion as to whether or not the tumor was a true adenoma or a mixed tumor. On the basis of a few reports of hypertrophy of the labial salivary glands in association with carcinoma of the lip, it has been suggested that the condition is precancerous. This belief is not strengthened by this study.

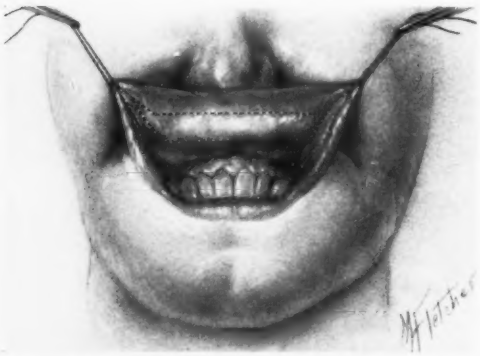

Fig. 15. Technique of cheiloplasty. Artist's sketch showing the outline of incision on the mucous membrane side of the lip through which a wedge-shaped section of the hyperplastic glandular tissue is excised.

Regarding therapy, it may be stated that surgical excision has given highly satisfactory results. Radium therapy, x-ray therapy, and injections of

boiling water have been suggested. Adequate follow-up notes are not available on the cases in which these methods have been used.

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THE TREATMENT OF LOW BACK PAIN DUE TO FUNCTIONAL DECOMPENSATION

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FUNCTIONAL decompensation is an imbalance between the capacity of the structures of the back and the physiological demands made upon them (1). A decompensation implies an insufficiency of structure and resultant disability. Just as cardiac decompensation does, so a decompensation of the back gives rise to certain symptoms and findings.

The symptoms are low back pain and tiredness; this fatigue of the back is often associated with a general fatigue. The primary symptom, however, is pain which is variable in character. The first pain noted is usually generalized and is in the muscles, with associated stiffness on arising after rest. Later the pain localizes and may involve the lumbosacral angle or the sacro-iliac joint. The interpretation is that the ligaments have been stretched and are inflamed. If the condition persists the joint becomes inflamed and a true arthritis develops.

The objective findings in decompensation of the back are impaired muscle tone and an increase of the normal curvatures of the spine, with tenderness over the lumbosacral and sacro-iliac areas. This means poor posture, a rounded dorsal kyphosis and increased lumbar lordosis and, in extreme cases, a right dorsal and left lateral lumbar curvature; the abdominal muscles are weak and the abdomen sags. In the acute phase of this condition there is a sudden catch, associated with lumbar muscle spasm, loss of the lumbar curve, a protective list with a pelvic tilt, and limitation of motion in the lumbar area. Associated with this condition we frequently find a low blood pressure, secondary anemia, nutritional deficiency, and a low metabolic rate. These are, in reality, causative factors. Sciatica is a frequent complication, explained on the basis of repeated stimuli caused by strain, together with a low nervous threshold due to fatigue; in other words, a neuralgia (2).

The essential pathological change is an inflammation in the region of the lumbosacral angle and the sacro-iliac joints. The alteration in posture is secondary to a functional decompensation which, after all, is the basis of the entire symptom complex.

TREATMENT

The treatment consists first, in relieving the inflammation; second, in correcting the deformity; and third, in re-establishing normal capacity. The acute inflammation caused by a sudden strain requires immediate bed rest; if it occurs during the course of the individual's occupation, he is advised to lie down until the muscle spasm relaxes. As soon as the acute spasm has subsided sufficiently, the patient is either strapped with adhesive or hospitalized. He is allowed to lie in the position he finds most comfortable, which is usually on the back with a small, soft pillow in the lumbar area, and the knees flexed. The amount of rest required depends upon the severity of the injury to the ligaments; a criterion to guide the surgeon is the rapidity with which the muscle spasm subsides; this varies from 12 hours to 10 days. If the patient is treated immediately after the injury, the usual time required is about 3 days. With the subsidence of the muscle spasm there is relief from the pain; the ligaments, however, are still far from healed. It is necessary further to protect the back in order to permit the patient to be up and about. The most simple method in order to accomplish this is to fix the lumbosacral and sacro-iliac areas with adhesive strapping.

The technique for proper strapping is to have the patient stand facing a table or desk, assuming the tallest attitude possible, with the abdominal muscles contracted, and to run strips of 2-inch adhesive from below the greater trochanter on one side to above the anterior sacro-iliac spine on the other side; horizontal strips are then applied from the sacrum well up into the lumbar area. This retains a fixation and at the same time insures correct carriage. The adhesive is worn for 3 to 5 days, when it is reinforced, since it tends to loosen. After from 7 to 10 days it may be necessary to restrap entirely the lumbosacral area. The back should be protected for from 10 to 21 days. The patient in the meantime is permitted to be about. If no previous functional insufficiency has been present, he will be able to continue with his usual work and obtain a complete recovery. Since a functional insufficiency of the back predisposes to these acute attacks, a very

high percentage of acute sprains are secondary to an insufficiency.

The functional decompensation of the back is associated with so called poor posture which means an increase of all the normal curves and a shifting forward of the body center of gravity. If the rounded dorsal kyphosis has been of long standing there is a tendency to fixation in this area; this fixation must be broken down and the abnormal curvature corrected.

The principle by which this correction is accomplished is based on the fact that 80 per cent of the motion of the spine is in the lumbar area which is mobile. With the patient bending forward, a body jacket is applied to fix the pelvis and the lumbar area. Any correction that occurs must, of necessity, be above the cast and in the dorsal area. The body-righting reflex automatically requires the patient to correct the rounded dorsal kyphosis (4). The bending forward plus overhead extension by means of a Sayre head-piece, tends to decrease the lumbar curve; this correction is retained since the cast is applied in an overcorrected position.

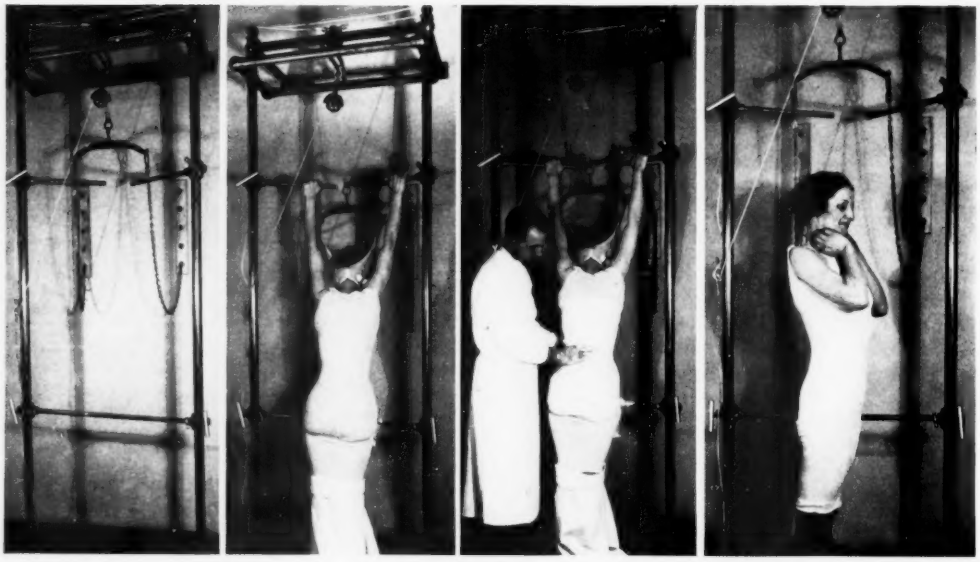
The technique by which this method is carried out is as follows: The patient is fastened to a crossbar on a vertical frame and the head-piece adjusted so that a satisfactory overcorrected position is established; the patient is tied to the crossbar and the Sayre extension is fixed so the position is retained until the cast can be applied (see photographs). The average cast requires eight rolls of fast-setting, 6-inch orthoplast plaster. After the cast is applied it is trimmed above and below; above, so that the cast comes to about the tenth dorsal vertebra in the back and slightly above the umbilicus in front; and below, so the patient can sit comfortably and is able to lace his shoes. To correct the deformity completely it is sometimes necessary to change the cast as many as three or even four times; occasionally a single cast is all that is required. The length of time that the cast is worn is determined by the rapidity with which the correction is accomplished. The recognition of correction is very simple since the cast becomes too loose and the patient pulls out of it. It is obvious that the cast does not change; therefore, the patient must have changed, and the change—if the position were correct—necessarily, will be in the nature of a correction of the deformity.

It is necessary not only to correct the deformity and protect the back against further irritation, which is accomplished by the cast, but it is also essential to re-establish the normal capacity of the back. When the cast has been applied, strain can no longer occur in the lumbosacral or sacro-iliac areas; the weight is transmitted from the dorsal area onto the pelvis by means of the cast. This protection permits the inflammation to subside even though the patient is up and about. A proof that this actually occurs is the frequency with which patients who have had low back pain for years are relieved immediately upon application of the cast.

To increase the capacity of the back it is essential that the structures have normal exercise, without strain. We have already learned how the cast protects against the strain. Since the cast ends in the lumbar area it is possible for the patient to pull himself up so that the cast does not support him. This stretching is the primary functional exercise. In addition, a system of exercises is prescribed with this fundamental principle as the basis (3). These exercises are supervised so that they are carried out with accuracy. As the muscle control and strength of the patient increase, more exercises are added; the exercises must always be practical. Since there is a general fatigue present in cases of functional insufficiency of the back, periodic rest is prescribed. This is done to avoid chronic strain and means that the patient lies down in any position he desires (he may read or listen to the radio) for from 10 to 30 minutes every 2 to 8 hours, depending upon the need of the individual. After each rest period the patient carries out the exercises. As soon as it is physically possible, sports are permitted. Frequently it is possible for the patient to play golf or tennis while the cast is being worn.

The secondary deformities are automatically corrected by means of the cast and exercises. The costal angle is increased; the lung expansion is enhanced, which means an increase of vital capacity; the pendulous abdomen disappears as soon as the muscles become strong enough to hold the abdomen flat, which results in a decrease of the waistline. Often the waistline decreases as much as 5 inches during the course of treatment, which is very gratifying to the patients, particularly the women. The association of weak feet and pes valgo planus with the functional decompensation is very frequent. Corrective shoes are prescribed and correct gait is taught, which means holding the erect position of the body and walking with the rolling gait.

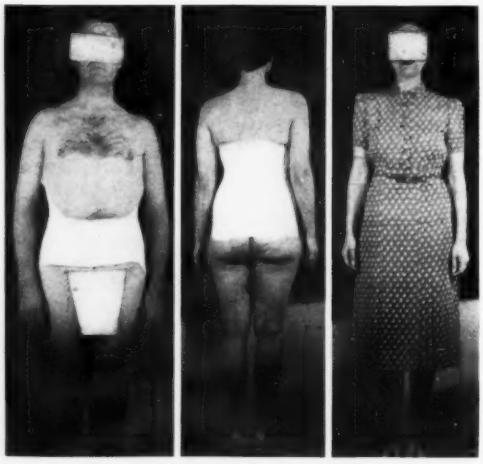
Very frequently the fatigue is due, at least in part, to malnutrition; this phase is studied and proper diet and tonics are prescribed. In consideration of Schanz's findings of osteoporosis of the vertebræ in cases of functional decompensation, it has been customary to prescribe calcium



a b c d

Fig. 1. a, Modified Haglund frame. b, Patient in position of correction of frame. c, Modeling cast. d, Lateral view of finished cast.

gluconate and dicalcium phosphate together with viosterol. When the deficiency is definite, large doses are used. Anemia and low hemoglobin are counteracted by means of lextron or ferrous sulphate. For the convenience of the patient who is carrying out his normal occupation, wherever possible, the tonics are prescribed in the form of capsules or tablets. When the nervous fatigue is great, vitamins B and G are prescribed. The low metabolic rate usually rises automatically as the fatigue decreases. The discriminate use of Lugol's solution has been found more effective than the thyroid extract which has been so frequently prescribed in these cases.



a b c

Fig. 2. a, Anterior view of finished cast. b, Posterior view of finished cast. c, Patient dressed, wearing cast.

The cast is worn until the correction is attained. The normal position is held with the last cast for a period of from 10 days to 4 weeks, depending upon the length of time the condition had been present before treatment was instituted. After removal of the cast, a corset is worn during the day to guard against strain; the corset is worn whenever prolonged sitting is necessary; it is advised particularly for those who earn their living by riding in a car. The exercises and periodic rest are continued until the capacity is sufficient to carry out all the requirements of the individual, which is usually about 3 months.

The re-establishment of capacity in the back prevents recurrences. During the process of re-establishing normal strength, as one might expect, acute attacks occasionally recur. In the desire to increase strength rapidly, the individual may

overstrain. These strains, however, subside promptly after a short rest period. The exercises are then carried out as usual. It is advisable to observe the patient at intervals of from 1 to 3 weeks to guard against strains and to encourage exercises until the maximum capacity of the back has been reached. Once normal capacity has been re-established, the patient no longer has any symptoms of backache while carrying on his normal occupation, without wearing a support. Not only has the backache been relieved during the course of treatment but the fatigue syndrome has also been lessened.

This treatment has been successfully carried out over a period of about 10 years. The primary objective of the treatment is relief of the backache and the secondary neuralgias, but just as important to the patient are the relief of the fatigue syndrome, the re-establishment of a normal outlook, and the improvement in appearance. In other words, the disability is cured and the deformity corrected.

To demonstrate these principles of treatment, I wish to cite 5 cases:

CASE 1. Miss N. H., 34 years of age, a school teacher; complained of nervousness, intermittent lumbago and low backache which had been present for 4 years; she was irritable, worried, and tired all the time; her back felt stiff on getting up; the pain was worse after prolonged sitting or standing; she obtained relief by lying down. For 5 months before she was seen she had had pain down the lateral side of the right thigh and leg, which had become worse until finally she was unable to walk. Relief was obtained only by constant rest and continued local heat.

At examination it was evident that she was suffering pain; she could not stand erect; any attempt at motion in the lumbar spine caused pain. There was a definite list to the left and slight atrophy of the right thigh and leg; there was lumbar muscle spasm, and the Lasègue sign was positive. The blood count and urine were normal; the blood Wassermann was negative. Roentgenogram of the lumbosacral area showed no abnormal change. A diagnosis was made of muscular insufficiency of the back, sacro-iliac strain, and right sciatica.

The patient was admitted to Passavant Hospital and bilateral Buck's extension was applied with the knees in flexed position. Local heat (an electric pad) was applied to the back, and she was given 10 grains of salicylate three times a day. After 5 days the muscle spasm in the back was relieved and a lumbar curve re-established. A small pillow was applied in the lumbar area and the patient was allowed to turn over on her abdomen; hot packs were applied for one-half hour three times a day. By the eighth day the back was well relaxed and the pain had disappeared. A plaster-of-Paris cast was then applied in the upright frame. The slight discomfort noted during the first night after the cast was applied was not sufficient to interfere with her sleep; the following day she was able to stand and walk, holding herself erect, with comfort. Exercises were started immediately and increased on the fifth day following the application of the cast. She was then seen at weekly intervals, and each time the exercises were increased. She left the hospital 2 days after the cast was applied.

On the twelfth day she had improved to such an extent that the cast was loose and no longer giving any support; a new cast, taking more correction, was applied and exercises and periodic rest carried out as before. In the beginning she rested 20 minutes out of each hour; by the time the second cast was applied the rest periods were lessened to five a day. She wore the second cast for 3 weeks. At that time she had a full correction with normal curves in the spine but, as there was still some tenderness over the right sacro-iliac joint, a third cast was applied which held the corrected position for another 2 weeks, after which a fitted cloth and steel corset was worn for another 5 weeks. During this period the patient was entirely free of pain, but the capacity of the back and abdominal muscles was still below normal. At the end of 9 weeks complete relief had been obtained. She continued her exercises without observation, and was next seen 1 year later; she had remained well during this entire period. Two years later she reported again, simply to say that she had had no further symptoms during the 3 years since her dismissal.

This case typifies the care of patients suffering with sciatica associated with low back pain due to muscular insufficiency of the back. The presence of nervous fatigue and the symptoms of muscular decompensation are characteristic for this group. The treatment consists in removal of the functional decompensation by the method described, and care of the nervous strain. The condition is explained to the patient; vitamins B and G are prescribed; and the social and economic problems are taken into consideration. There is a definite response to treatment.

CASE 2. Mrs. H. B., 26 years of age, a housewife; complained of pain in the lower part of the back, which had been present for over 10 years, worse after childbirth; very severe after birth of her second baby; she was exceedingly tired all the time; the backache had been continuous for 2 years with periodic exacerbations. A diagnosis of right sciatica had been made following her first pregnancy; this pain in the right thigh had recurred periodically ever since. She had had trouble with her feet, slightly relieved by the wearing of stiff-shanked shoes; she had had some osteopathic treatment. Her general health was excellent.

Examination showed an intelligent young woman with a rounded kyphosis in the dorsal area and a slight right dorsal scoliosis; the lumbar curve was increased and the abdomen tended to sag; the muscle tone in the extremities was good but the abdominal and back muscles were weak. A diagnosis of muscular insufficiency of the back with sacro-iliac strain and right sciatica was made.

The back was strapped with adhesive as a test; on the third day she returned stating that she had had more relief than she had had for 3 years. The following day the adhesive was removed and a plaster-of-Paris jacket applied; this gave her immediate relief. Exercises were started at once. After 10 days the cast was cut to the level of the twelfth dorsal vertebra in back. The dorsal curve showed correction. She used a sand-bag and the exercises already described; these were gradually increased. After 2 weeks the cast was so loose that it no longer gave support; a new cast was applied, at which time her back was found to be in normal position. She continued her exercises and wore corrective shoes. At the same time the periodic rest which was started at the onset of treatment was decreased from 20 minutes every 2 hours to three rest periods of 20 minutes

each, daily. Four weeks later the cast was removed and she was fitted with a corset.

During this entire period she had had no pain in the thigh; the backache was relieved but did recur after severe strain incident to the care of her sick child, lasting about 1 week. She has been well ever since; she is able to play tennis and golf and carry out her usual duties; she gained three-fourths of an inch in height; the dorsal kyphosis which had been present since her adolescence, was entirely relieved. For the first time her posture was satisfactory to herself and to her parents; the abdomen was flat and her hip measurement was 2 inches less than before treatment; she is no longer fatigued but energetic and active.

This case is characteristic of a group of neglected adolescent scolioses, who develop a functional decompensation as young adults, or in later life. The cure of the functional decompensation relieves the symptoms of which the patient complains and corrects the deformity present.

CASE 3. Mrs. C. D., 38 years of age, a housewife; complained of backache which had been present for 10 years, worse after the birth of her only child; she was awakened mornings by the pain in her back, which increased after driving a car or sitting in a chair; back felt stiff on arising; pain worse with change of weather. She was tired most of the time; she was an active woman but because of her backache was unable to do the things she liked to do, and had gained about 10 pounds in weight. During the last few months before she was seen she had had pain in the lower extremities, limited to the thighs; sometimes one thigh was involved, sometimes, the other, never both at the same time. She had obtained some relief from lying in the sun, and the backache had subsided while she was in bed following an operation. She had received various types of medical care, including salicylates, bed rest and heat; she had been placed on a Bradford frame, and had worn a belt—all without relief. She did obtain relief during her rest periods but on getting up again the back seemed worse than before. Orthopedists had advised a fusion operation.

At examination the back showed an increased rounded dorsal kyphosis; an increased lumbar lordosis; sacro-iliac tenderness on both sides; and tenderness over the lumbosacral angle. X-ray examination of the lumbar spine was negative. The abdomen sagged and she had gained weight, especially about the thighs; the costal angle was narrow. She walked with a shuffling gait, and had a facial expression of fatigue and strain.

She entered the hospital for 2 days for a general examination. During this time hot packs were applied three times a day. On the third day a body-jacket was applied, which gave prompt relief. General exercises were started and gradually increased in the usual manner. She was given corrective shoes and taught the normal gait. On the second day after the cast was applied she was permitted to return home—an overnight journey.

When seen 2 weeks later the cast was loose; she had already obtained a great deal of correction in the dorsal area. A new cast was applied, with further correction of position. Viosterol, 15 drops, and calcium gluconate 7½ grains, three times a day, were prescribed. She felt very much better.

Two weeks later the cast was trimmed and made lower; periodic rest was continued. She still had some pain at the lumbosacral angle, particularly after strain or prolonged sitting.

After another 2 weeks a third cast was applied; the position of the back was then entirely corrected and the new cast applied in the overcorrected position; this gave complete relief. She continued her exercises, began taking walks and playing tennis.

Four months after the institution of treatment, the third cast was removed and a satisfactory corset fitted. Her general condition was very good. She had lost 3 inches in hip measurement and had gained about 1¼ inches in height; the costal angle was broader, and she no longer felt fatigued; her backache had entirely disappeared. For a period of 2 months, however, she had to guard against prolonged sitting, particularly riding in a car, which would cause some stiffness in the morning on arising. She has now been entirely well for a period of 6 months.

This case is typical of a group of cases in which the condition was of long standing, and in which medical care and orthopedic measures had been attempted, until finally a fusion operation had been advised. The immediate response to treatment in the way of relief of symptoms, even though of long standing, was striking. With relief of the backache the general health of the patient is improved; the functional capacity is increased; they have a feeling of well-being and in many instances the blood pressure and the metabolic rate are increased, as is also the vital capacity.

CASE 4. Mr. D. J. M., 57 years of age, a retired business man; complained of pain in the right lower extremity and lower part of the back, which had been present for over a year. He first noticed a constant fatigue, so marked that everything he did was an effort; decided to take a vacation and play golf. Enroute to Florida he developed pain in the right sacro-iliac area and right thigh, which became progressively worse and radiated down along the knee and into the calf; pain was worse when riding in a car, playing golf, or walking over rough ground. He obtained some relief by lying in the sun in the warm sand on the beach, but on his return home the pain continued; he was stiff on arising in the morning and was unable to play golf. His general fatigue, the pain in the back and the nagging pain in the sciatic region continued to get worse, and he consulted a physician for a general examination. Several teeth were extracted and a tonsillectomy done without improvement. He had his shoes made by a special shoemaker.

Examination showed an elderly man, definitely overweight, with a pendulous abdomen; the abdominal muscles had very poor tone so that he could draw the abdomen up only slightly; he wore an abdominal support. There was marked valgus at the ankle and at the knee, and pronation of both feet. X-rays showed slight hypertrophic arthritis in the lumbar area. A diagnosis of muscular insufficiency of the back with sacro-iliac strain, and pes valgo planus with foot-strain, was made.

His back was strapped with adhesive, and his shoes padded; he obtained immediate relief. Two days later he returned, eager to carry out further treatment. The adhesive strapping was removed and a plaster-of-Paris cast was applied with corrected position; the following day the cast was trimmed. Two days later he stated that he was comfortable and had no backache. Exercises were started; he was given corrective shoes and taught the normal gait. When seen 10 days after the application of the second cast, he had gained a great deal of correction and was delighted with his improvement; he stated that he had not felt so well in years. After he had worn the second cast for 2 weeks his posture was satisfactory, but the abdomen was still a

little prominent, and a third cast was applied; this he wore for 2 weeks. He was then put into a form-fitting corset; he took a vacation, continued his exercises, began to play golf again, and took up swimming; gradually he left off his support. He has continued to feel well for a period of about a year.

This is an example of static arthritis, secondary to mechanical strain, in older patients. The treatment is practical in that even a man of 57 years does not find it too strenuous. This patient felt that his general improvement justified the treatment. The back pain and sciatica disappeared with the cure of the decompensation.

CASE 5. Mr. J. R. W., 32 years of age, a gas-house foreman; in 1931 he had twisted his back and noted sharp pain; his physician made a diagnosis of lumbago and wrenched back and treated him, with some benefit; at intervals since then he has awakened mornings with a tightness in the back, and has had recurrent sharp attacks, lasting from 2 to 3 days; attacks gradually became more frequent and more severe until finally he had a constant backache while at work; 6 months before he was seen his legs had begun to ache; he felt tired all the time. He had been examined and treated for sacro-iliac arthritis, definitely shown by the x-ray. Chronically infected tonsils and several infected teeth had been removed; he had been given salicylates and tonics—all without relief.

Examination showed an increase of all normal curves; lumbar muscle spasm; tenderness over the lumbosacral angle and in the sacro-iliac area. A diagnosis was made of muscular insufficiency of the back with sacro-iliac strain.

Treatment was started immediately. A plaster-of-Paris cast was applied and he obtained immediate relief. He continued to work while wearing the cast; resting at noon and again immediately after work; he carried out his exercises after these periodic rests. In addition he was given corrective shoes and taught the normal gait; a sandbag was used to get proper posture. After 2 weeks the cast was changed. He lost no time from his work and had no further pain after the application of the first cast. He continued to gain strength; the capacity of the back improved so that the cast was lowered each week. The second cast was worn for 3 weeks, after which he was fitted with a corset. He was also given calcium gluconate and viosterol.

He has remained well for more than a year. He has no backache and no feeling of fatigue, and he states that he has not felt so well in 5 years.

This case is typical of a group of adults who are dependent on hard labor for earning their living. Though of long standing and recalcitrant to medical treatment, the response to measures directed against the functional decompensation was immediate. The treatment was executed with the patient ambulant and able to do his work.

CONCLUSIONS

1. Functional decompensation of the back (an imbalance between the capacity of the back and the load or the work demanded of it) is a very common cause of low back pain.

2. Anything that increases the demand or decreases the capacity of the back is, therefore, a causative factor.

3. The backache is primarily due to an inflammation at the lumbosacral angle and sacro-iliac joints.

4. The treatment consists first, in relieving the inflammation by proper adhesive strapping of the back; second, in re-establishing normal posture by the application of a corrective or active plaster-of-Paris cast; and third, in re-establishing the normal capacity of the back by means of a system of practical exercises.

5. Dietary deficiencies frequently cause a decrease in physical capacity. These deficiencies are evaluated by the attending physician who outlines a proper diet; viosterol and calcium are useful in bringing about a restoration.

6. Anemia, which is frequently present, is treated with liver extract (lextron) and iron (ferrous sulphate). Nervous fatigue is combated by means of vitamins B and G.

7. Low back pain is, thus, frequently a part of a general condition and is treated accordingly.

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CORRECTION OF CYSTOCELE AND RECTOCELE IN THE PROCESS OF SUPRAVAGINAL HYSTERECTOMY

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THREE years ago I was confronted with a case of myomatous uterus in the third degree of procidentia with a cystocele and rectocele, the uterus being too large to be removed *per vaginam*. In addition, the condition of the patient did not warrant an operation entailing the time necessary for the systematic correction of all the pathology present. I have accordingly devised a technique whereby the cystocele and rectocele would be automatically eliminated by a few modified steps in the technique of supravaginal hysterectomy.

After the round ligaments were ligated close to the uterus, and the rest of the steps completed, the body of the uterus was severed from the cervix. A taut bridge was then formed of the round ligament pedicles by overlapping them as shown in Figure 1. This forms the cardinal step in the mechanism of the new technique. In the next step I elevated the stump of the cervix and attached it to the undersurface of the ligament bridge (Figs. 1 and 2). This is in the reverse order of the usual technique in which the round ligament pedicles are attached loosely to the prolapsed cervix (Fig. 4) and in which the vaginal wall and cystocele and rectocele maintain their status quo (Figs. 4 and 5), unless repaired.

With the elevation of the cervix the vaginal wall, including the rectocele and cystocele, came along to the extent of obliteration of the latter two. Peritonealization was carried out in the usual manner (Figs. 3 and 4).

Since then I have had three other such cases which I have operated upon in the same technique with the same uniform good results. At the present time the cervix, in all these cases, is still on a high level and the rectocele and cystocele do not come down on straining.

The relaxed vagina, whether it be due to cystocele or rectocele, or to prolapse or relaxation as a result of procidentia, will be obliterated to the distance between the round ligament bridge and the location of the prolapsed cervix. And that usually is a distance of from 1 to 1½ inches (compare Fig. 3 as contrasted with Figs. 4 and 5).

Encouraged by these results, I proceeded to employ this method in all cases of supravaginal hysterectomy without procidentia, but with rectocele and cystocele. In 37 of 43 such cases the cystocele was corrected completely. In the

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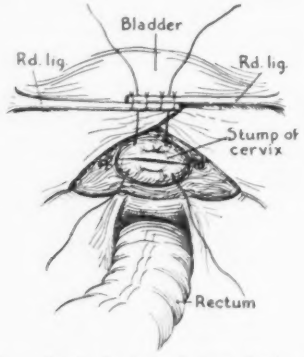

Fig. 1. A perfectly horizontal taut bridge has been formed of the round ligament pedicles, by 3 or 4 sutures placed and tied in a manner so that ¼ of the long section of each pedicle remains free (circulation not obstructed). It also shows 2 sutures (more if necessary) passed through the bridge and the cervix as the first step in the elevation of the cervix to the undersurface of the bridge. It will be noticed that here, likewise, the sutures are passed through the bridge with the view of guarding against obstruction of the round ligament circulation. As stated in the context, the round ligaments should be cut as closely as possible to the uterus; and for two reasons: (a) if they are short a bridge cannot be formed; (b) the larger the pedicles are, the more they will overlap each other, thus enforcing the ultimate support against theoretical or probable ravages of the intra-abdominal pressure.

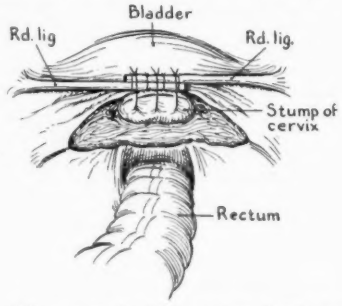

Fig. 2. Shows the cervix united to the undersurface of the bridge. Here the cervix does not appear to hug the round ligament snugly. This is done with the object of more clearly showing the steps of the technique.

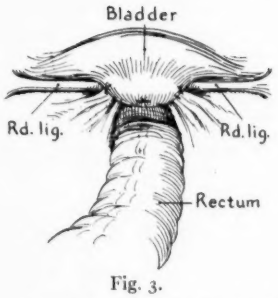

Fig. 3.

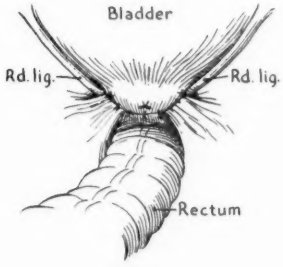

Fig. 4.

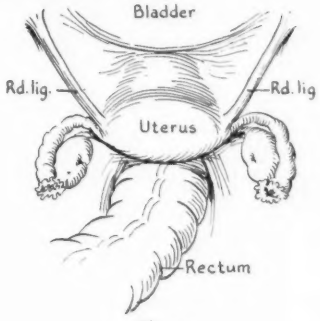

Fig. 5.

Fig. 3. Peritonealization finished. The cervix is elevated 1 to 1½ inches, and to that extent the vaginal wall, including the rectocele and cystocele, is elevated. On account of the difficulty of illustrating the actual elevation of the vaginal wall, this phase of the operation is left to the imagination.

Fig. 4. (Old technique.) The round ligament pedicles are brought down to prolapsed cervix. Position of vaginal wall, including cystocele and rectocele, remains unchanged.

Fig. 5. (Old technique.) It shows the round ligaments long and relaxed and the uterus retroverted and prolapsed. In procidentia the uterus is as a rule retroverted.

6 other cases about 1/5 of the original cystocele would still come down on straining. This is undoubtedly due to the uterus not having been amputated low enough. But we get such degree and percentage of failures even after cystocele operations. Of rectoceles it was mostly successful in cases associated with prolapse or sagging of the posterior vaginal wall. Judging from results obtained, it seems that there is sagging of the anterior vaginal wall in all such cases and of the posterior wall to the extent of a varying fraction.

In those conditions in which supravaginal hysterectomy (without procidentia) is indicated, but in the presence of cystocele and rectocele, I obtain a preknowledge as to results and indication for operation on the latter, as follows:

I hook a tenaculum on the anterior lip of the cervix, through a speculum. I then remove the speculum and elevate the uterus by pushing up on the tenaculum. Now I ask the patient to bear down. If the cystocele and rectocele do not come down they can be left out of consideration, depending for their automatic correction on the hysterectomy technique. Lately I employ a simpler test. I elevate the cervix with a dressing forceps holding a short tampon of cotton.

I am frequently told by men who have watched my technique and who concede that the vaginal wall is thus elevated, that they fail to see how the round ligaments could be depended upon for permanent support of the structures. The objection is unsound practically. First of all and foremost there is no longer present the large and heavy uterus with its overstretched supports (non-supports), which acts adversely by its own weight and upon which intra-abdominal pressure is directed. Second, the overlapping tense bridge removes any "sag" in the round ligaments as well as of the broad ligaments; the cervix, relatively light, is attached to the undersurface of the bridge; the attachment of the tubo-ovarian pedicles to the cervix and the peritonealization with the bladder fold covering all the superimposed structures on the cervix and beyond, form one consolidated, well distributed support, invincible to caprices of intra-abdominal pressure.

CHOLANGIOGRAPHIC DEMONSTRATION OF THE REMAINING COMMON DUCT STONE AND ITS NON-OPERATIVE MANAGEMENT

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SINCE adopting the rule several years ago of making delayed cholangiographic studies in all cases of common duct drainage or biliary fistulas, we have been able to prove, for ourselves at least, that thorough exploration of the common duct at operation by palpation, probing, scooping, irrigation, and suction does not always verify the presence of stones. If they are present and are not identified by palpation, they may not always be removed by such measures. Also it is plausible that these remaining common duct stones may frequently be stones which have descended from the liver. This can be fully appreciated only by those who have investigated the postoperative status of the common duct through delayed cholangiography. If abdominal palpation alone were used as the basis of determining the frequency of cancer of the stomach, before it invades other organs, the figures would be far amiss as x-ray examination with the use of a contrast medium is essential. We believe that this holds true also with the remaining common duct stone. We all appreciate that patients not infrequently continue to have right upper quadrant distress after an apparently successful cholecystectomy. At times this has been proved due to spastic dyssynergia of the sphincter of Oddi, or to cholangitis, pancreatitis, or hepatic disturbances. That remaining stones, mucous plugs, blood clots, or organized débris within the intrahepatic or extrahepatic biliary ducts account for some of the postcholecystectomy syndromes has been forcibly brought to our attention by our experiences with cholangiography.

Just how frequently the common duct should be opened and explored is difficult to ascertain but no doubt it should be done more often than is commonly advocated. Lahey's statement that between 1910 and 1926 his group had opened the common ducts in 15.5 per cent of their gall bladder patients and had discovered stones in 8.4 per cent is illuminating. They gradually began to explore the common duct more frequently until between 1930 and 1931, of 138 patients operated upon, 42.5 per cent were explored and stones were discovered in 21 per cent. It is noteworthy that approximately 50 per cent presented stones, regardless of the number of common ducts explored. It is also significant that 38 per cent of their patients with common duct stones were not jaundiced. Secondary attacks upon the common and hepatic ducts are not only difficult but hazardous, resulting in a rather high mortality. Fully cognizant of these facts, we have attempted to dislodge remaining stones and other foreign bodies by various measures.

Our first attempts consisted merely in following the established method of irrigation through the T-tube or catheter, with or without the use of atropine and morphine, alone or in combination. We feel confident that in the past smaller stones, mucous plugs or débris were not infrequently washed into the duodenum, thus obviating secondary attacks upon the biliary tract with their attendant mortality. After deriving more knowledge of the pathological physiology of the common duct from cholangiographic studies, a more scientific and practical attack was formulated.

That spasm of the sphincter of Oddi may exist is no longer a debated question. It has been proved by Westphal, Newman, Ivy and Sandblom, Saralegui, and Best and Hicken, among others. This sphincter may be either in a completely relaxed, unrelaxed (achalasia) or spastic state (spastic dyssynergia). The work of Meltzer and of Lyon in non-surgical drainage of the gall bladder by means of tube and magnesium sulphate hypothesized the necessity of a relaxed sphincter of Oddi in order that bile might pass freely into the duodenum. The administration of fat (cream) by mouth in cholecystography to empty the gall bladder also suggests direct or indirect relaxation of the sphincter area to permit free drainage of bile into the duodenum. For years atropine has been considered efficacious in relaxing the sphincter, but recent studies have proved that it is variable and not to be entirely depended upon, although it should by no means be discarded.

From the Department of Surgery, University of Nebraska College of Medicine.

Presented at the meeting of the Western Surgical Association, Indianapolis, Indiana, December 3, 1937.

The first step in attempting to remove a stone or foreign body from the common duct is to provide for the free egress of ductal contents into the duodenum. The lower end of the duct is guarded by the sphincter of Oddi which is probably associated with a pseudo-sphincteric action of the muscular fibers of the duodenal wall itself. At the American Medical Association meeting in 1936, we presented a paper (4) on cholangiography which proposed that nitroglycerin encouraged relaxation of the sphincter[1] and permitted the contrast medium to pass easily from the common duct to the duodenum. Also in 1936, Walters (9) and his group reported their experiments on common duct pressure as affected by spasm of the sphincter and the decrease in pressure afforded by both nitroglycerin and amyl nitrite. More recently, Doubilet and Colp have corroborated the effect of nitroglycerin. Our observations upon the spastic or non-relaxing effect of morphine certainly agree with those of Walters and Doubilet and Colp. The experiments of the latter two men also concur with ours in showing that atropine may relax or at least lessen the tension in this irritable sphincter area in some instances. We have previously reported upon the apparent soothing or relaxing effect of warm olive oil or iodized oil upon the choledochal side of the common duct sphincter when instilled through a T-tube or fistula. The effect of magnesium sulphate or fats such as olive oil or cream upon the duodenal surface has also been mentioned.

The second problem is to dislodge the foreign body by increasing the pressure behind it. If the stone or foreign body is below the T-tube, catheter, or fistula opening, this is easily accomplished by the injection of warm saline solution, olive oil or iodized oil through the tube or fistula.

It is also reasonable that increasing the flow of bile by stimulating its formation will augment the intraductal pressure. Neubauer in 1924 determined by experiments on animals and humans that sodium dehydrocholate, the sodium salt of dehydrocholic acid, increased the secretion of bile. We have, therefore, been experimenting with pressure changes effected by dehydrocholic acid, and Figure 1 is an example of increased intraductal pressure brought about by this means. The usual dosage has been 3 tablets (3¾ grain or 0.25 gram each) four times a day. A rise in pressure occurred in most instances, but there was considerable variation in the degree of change. At times it would increase 200 millimeters of water, while at other times a change of only 10 to 20 millimeters was apparent. We have also used the

[1] 1/100 grain tablet dissolved under the tongue.

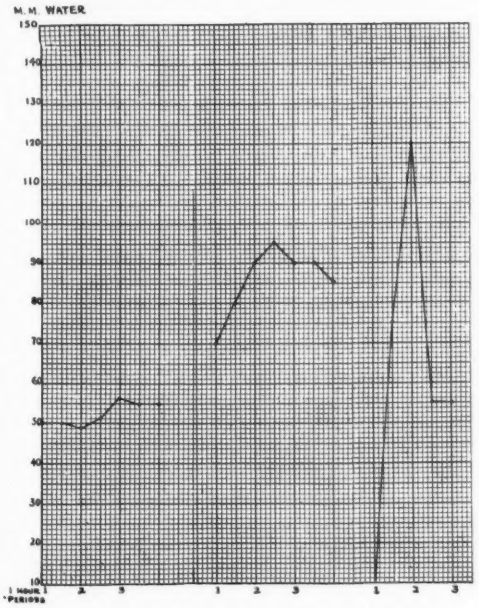


Fig. 1. The general level of intraductal pressure during the administration of dehydrocholic acid is definitely higher than during control periods. With the intravenous injection of sodium dehydrocholate there was a sudden rise in intraductal pressure. Case A. S. cholecystostomy and choledochectomy.

sodium salt of this drug intravenously but do not feel that we have had sufficient experience as yet to advocate its routine use. This added pressure is of maximum value when the foreign body is below the T-tube or catheter inlet or when only a biliary fistula exists, as it tends to force the impediment through the sphincter during a momentary relaxation. The secretory pressure of the liver is said to lie between 200 and 300 millimeters of water while the sphincter resistance or breaking point is about 150 millimeters, but our experience with the breaking point in the postoperative case shows it to vary from 0 to 175 millimeters. Clamping the tube or lightly packing the fistulous tract may or may not be necessary. Our experience has not been sufficient to warrant a definite statement.

If a stone is lodged above the upper limb of the T-tube or tip of the catheter, it is necessary to remove the tube before the stone can pass to the lower end of the common duct. An increased pressure in the biliary ducts may also wash smaller stones down from the liver, as definitely proved in one of our cases.

The first case presented illustrates the pos-

sibility of dislodging a stone from the common duct by this method after first permitting the edema in the sphincter area to subside.

CASE 1. Mr. O.M., aged 35 years, had recurrent attacks of indigestion over a period of 16 months, accompanied by pain in the upper abdomen, nausea, and vomiting. Morphine was required for relief and upon one occasion he became slightly jaundiced. The week before he entered the hospital, he developed a severe pain in the upper abdomen which necessitated several hypodermics of morphine for relief and within 3 days he became icteric. When examined, the patient was very apprehensive, definitely jaundiced, and moderately tender over the gall bladder. His icteric index was 75, the van den Bergh direct delayed reaction was moderately positive, the stools contained bile, his temperature was 99.8 degrees, and he had a leucocytosis of 10,600. By conservative management the icteric index was brought down to 35, and after 5 days of observation and preparation, the patient was operated upon with the diagnosis of cholecystitis, cholelithiasis, and common duct stone.

First operation. Under spinal anesthesia, the gall bladder, thick walled, definitely inflamed and adherent to surrounding structures, was removed. The common duct was about twice normal size and was angulated at its junction with the cystic duct by inflammatory adhesions. These were freed and the duct opened. Thorough palpation, probing, scooping, and irrigation revealed no stone. The head of the pancreas was thickened and harder than normal. A T-tube was placed in the common duct for drainage purposes.

Cholangiogram. On the sixth day after operation, a cholangiogram was made by injecting 20 cubic centimeters of hippuran solution into the common duct through the T-tube. No stone was visible but the sphincter appeared contracted. This spasm was relaxed by dissolving 1/100 grain of nitroglycerin beneath his tongue. The T-tube was removed on the tenth day after operation following a check-up cholangiogram which again revealed some sphincterismus but no stone. The patient was discharged from the hospital a few days later with a remaining biliary fistula. During the next 2 months, he had continued attacks of chills, fever, upper abdominal distress, and intermittent jaundice. The sinus tract would close off, only to reopen and drain pus and bile. This occurred a number of times.

Cholangiogram. About 10 weeks after the first operation, another cholangiogram, with 20 cubic centimeters of hippuran solution, revealed 2 stones in the common duct which had not been visible previously. Operation was advised.

Second operation. An attempt was made to locate and move the stones from an enlarged common duct. The head of the pancreas was also larger than normal, quite hard, and irregular, as is consistent with marked chronic pancreatitis or new-growth. There was a pronounced inflammation around the common duct and duodenum. The duct was explored as thoroughly as possible in the presence of this inflammatory reaction, using finger, probe, scoop, irrigation, and suction, but no stone could be palpated or dislodged. The patient's unsatisfactory condition contraindicated a transduodenal attack. Therefore, a T-tube was hurriedly placed in the common duct and the abdomen was closed.

Cholangiogram. Because of digestion of the tissues around the wound, a cholangiogram was not taken for 3 weeks, at which time the picture was a little suggestive of a single stone in the region of the ampulla. A recheck 4 weeks later definitely revealed a stone at the lower end of the common duct (Fig. 2a). The entire length of the pancreatic duct was easily visible.

Cholangiogram. The previously suggested regimen was immediately started and was repeated every 10 days. In the intervals, the duct was washed out on alternate days with sterile olive oil or lipoiodine. With each oil irrigation 1/100 grain of nitroglycerin was placed beneath the tongue. After 1 month, a follow-up cholangiogram showed the stone still present but the opaque medium entered the duodenum more readily. After a second month of treatment, no evidence of a filling defect could be found at the lower end of the common duct (Fig. 2b).

The T-tube was then clamped off, except at night, for another 30 days when a recheck showed no indication of stone in the duct. This warranted removal of the T-tube and now, 10 months later, the patient weighs more than he ever did, feels perfectly well, and is back at his regular duties.

Evidently in this case common duct drainage and time were needed for the pancreatic inflammation to subside and then proper measures dislodged the stone.

We have come to believe that stones are present in the larger biliary ducts of the liver more frequently than is recorded. More detailed examination of the liver at autopsy would support this statement, for during the last year we have demonstrated such stones in two instances but only after thorough search. One of these was a patient with a postoperative common duct stone who also had an unrecognized carcinoma of the kidney. The other case was one in which a routine autopsy was performed after the patient had succumbed to cardiovascular disease.

The following case is presented because it demonstrates more vividly the release of intrahepatic stones into the common duct. These stones were detected in the common duct by cholangiography and then were successfully dislodged by the aforementioned regimen.

CASE 2. For 5 years, Mrs. R.C., aged 28 years, had been having attacks of nausea and vomiting, which were associated with loss of appetite, slight upper abdominal distress, but no true pain. Removal of her appendix did not alleviate the symptoms but rather the attacks became more frequent. Three days before entering the hospital she was suddenly seized with a sharp pain in the right upper quadrant which radiated to the right scapular region. The paroxysm subsided under morphine. She presented no history of jaundice, but for some years she had noticed a pressure sensation immediately following meals which would last for half an hour and was not relieved by soda.

Examination revealed a well developed young woman in no apparent distress. The only positive finding was slight tenderness over the gall bladder. No rigidity and no definite masses were palpable. Her temperature and pulse were normal, the white blood count was 10,400 and the icteric index was 10.

Operation. The large, distended gall bladder was adherent to the duodenum. The common duct appeared two or three times normal size, with no stones palpable in its lumen. After the gall bladder was removed, it was incised and found to contain about 200 pea size stones. The common duct was opened through the stump of the cystic duct, but palpation, probing, scooping, suction, and irrigation re-

Fig. 2. a, left. The cholangiogram reveals a stone lodged at the lower end of the common duct. There is an associated pancreatitis and the pancreatic duct is well visualized. b, The stone has been dislodged. Pancreatic duct still visible.

vealed no stones. A catheter was then placed in the common duct and the abdomen closed.

Cholangiogram. One week after operation a cholangiogram made with 20 cubic centimeters of hippuran solution revealed multiple stones in the common duct (Fig. 3a). This was repeated several days later with the same picture.

As soon as the patient's condition warranted it, the previously described therapeutic measures were begun. After the first course of treatment, 10 stones were recovered from the stools. The cholangiogram was repeated and one stone was found remaining in the ampulla (Fig. 3b). A second course of treatment resulted in passage of the 11th stone (Fig. 4a). Two subsequent check-ups were negative. The fistula soon closed and now, 10 months later, the patient feels perfectly well.

We have been able to depict apparent foreign bodies in two other common ducts by postoperative cholangiograms, with defects irregular and inconstant in shape and position. It is highly possible they were small blood clots, mucous clumps, or lumps of inspissated bile which were dislodged (Fig. 5). In any event, they disappeared under the described treatment. In a recent case, although none could be palpated, a very large stone was revealed in the common duct on the postoperative cholangiogram. Repeated efforts to dislodge it have been ineffectual and ether as advocated by Pribram has also failed to break it up (Fig. 6). We have also had a failure with ether in an elderly woman with a gall-bladder fistula and cystic duct stone. However, from the report of Pribram, it is a method which has possibilities.

SUGGESTED TECHNIQUE FOR REMOVAL OF REMAINING COMMON DUCT STONES

When a stone or foreign body is identified in the common duct by delayed cholangiography, the following 3 day regimen is begun. On the first day a 1/100 grain tablet of nitroglycerin is dissolved under the tongue 3 times during the day; on the second, 1/100 grain of atropine is given 3 times, either by mouth or hypodermically; on the third day, the nitroglycerin is repeated. Each morning the patient is given 2 drams or more of magnesium sulphate in warm water and at bedtime, 1 ounce of olive oil (preferably) or thick cream. The common duct is gently irrigated every day through the drainage tube or fistula with warm normal saline solution, and after removing as much of this solution as possible with the syringe or by permitting the tube to drain for 5 minutes, 10 to 30 cubic centimeters of warm sterile olive oil are instilled. At times, lipoiodine or lipiodol seems to exert a more beneficial effect. If the patient does not complain of distress, the tube

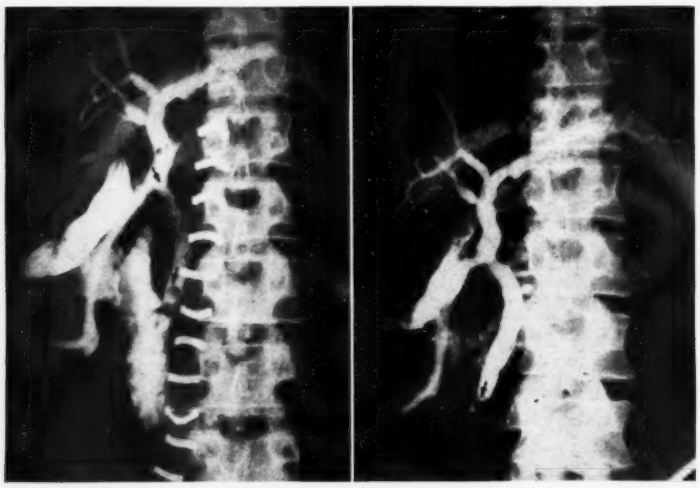


Fig. 3. a, left. The cholangiogram reveals multiple stones in the common duct. b, After the first course of treatment all but one stone had been removed and 10 recovered from the stool. Note rounded filling defect at lower end of common duct.

should be clamped off during the course of treatment except for 1 hour after each instillation of oil. Three to five decholin or procholon tablets (3¾ grain) are given 4 times a day to increase and maintain the pressure within the common duct so that during some momentary period of relaxation, the stone or foreign body may escape from the duct.

This treatment may be repeated after a day's rest and as in the second case reported, it may be administered as many as ten times over a period of 2 months. It may prove rather exhausting at times, and a little caution must be exercised.

The question arises as to the indications for this form of treatment where no fistula or catheter set-up for irrigation exists. If obstruction is complete, there may be danger of hastening liver destruction by increasing biliary pressure. We have ventured to use this method in several cases in which obstruction was not complete, with no evident harmful effects and with definite clearing up of the apparent biliary condition. We have

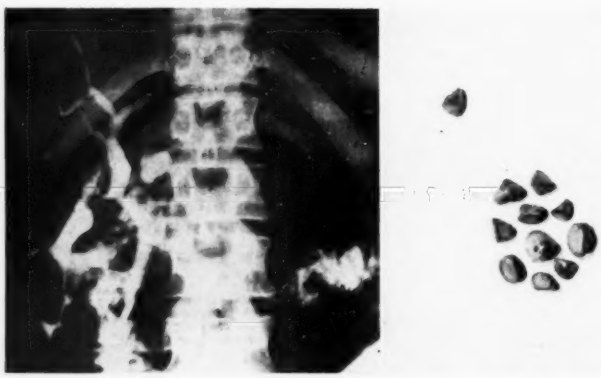
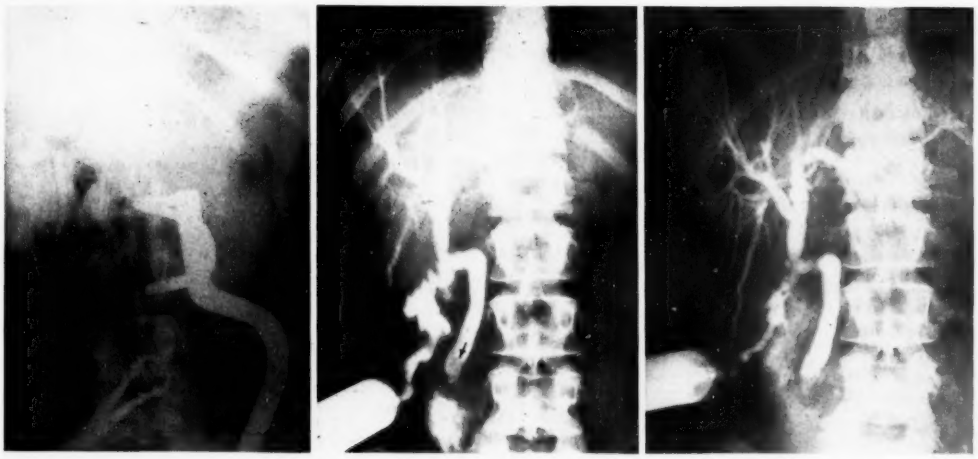


Fig. 4 (same case as Fig. 3). a, left, After the second course of treatment the single remaining stone was dislodged and the contrast medium freely entered the duodenum. b, The group of stones were recovered first. Later the single stone was recovered.



a b c

Fig. 5. a, Cholangiogram at the table reveals no filling defect of the narrow common duct. b, After 2 months with a persistent draining biliary fistula, a defect inconstant in size and shape was revealed on the cholangiogram. c, After described treatment, the defect disappeared and in 7 days the fistula was closed.

recovered no stones from the stools in such instances, but the patient's search for these is not always exacting. Again, dislodgement of mucous plugs or inspissated bile may account for the therapeutic result. One should always keep in mind the potential danger of such treatment, and until further investigative studies have been made, the dehydrocholic acid products should be prescribed cautiously in any degree of jaundice with supposition of stones in the common duct. If the jaundice is marked and the stools are acholic, great damage might be done to the liver

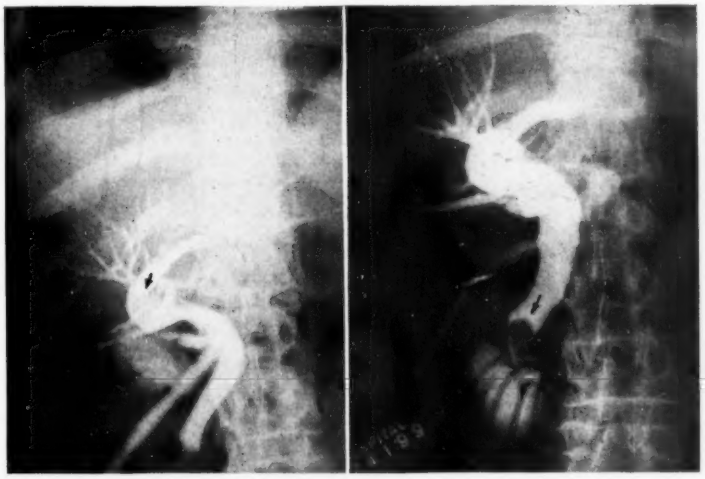


Fig. 6. a, left, Stone is lodged above the upper end of the T-tube. b, After removing T-tube and increasing biliary pressure, stone arrived at lower end of common duct. It could not be dissolved by Pribram's ether method nor could it be forced into the duodenum.

and dehydrocholic acid should definitely not be prescribed.

This method of postoperative biliary tract flush is being instituted in more and more of our routine gall-bladder cases in the hope of washing out remaining mucous plugs, blood clots that may originate from trauma, or inspissated bile which might be the nucleus of a stone, as well as to remove any remaining smaller stones, and thus avoid the later appearance of the so-called postcholecystectomy syndrome.

Decholin (Riedel de Haen) and procholon (Squibb) were the dehydrocholic acid products used.

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RETRACTION RING DYSTOCIA

Its Cause and Correction

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FOR many years uterine rings have been recognized as a cause of dystocia, yet the subject is one upon which the obstetrical world still seems to be rather confused. In a review of the literature, one finds that Braune, in 1872, wrote of a ruptured uterus from ring dystocia. Bandl, in 1875, defined a ring at the juncture of the upper active uterine body and the lower inactive cervix. Schroeder described a ring in normal labor at the union of the upper and lower uterine segments, which he designated a "contraction ring." Barbour and Lusk, also, were familiar with this ring, but, on account of the increased thickening of the body of the uterus, called it "retraction ring." More recently, Holmes, White, Harper, Fitzgibbon, and others, have written upon the subject.

During the past year, Rudolph, of Chicago, read a paper before the Obstetrical Section of the American Medical Association, on constriction ring dystocia. His report covered a series of 371 cases of ring dystocia, in which the maternal mortality was 15 per cent and the fetal mortality 46 per cent. No doubt these figures are not exceptional, yet, obviously, something is wrong with a situation in which the mortality could be so high. A clearer conception of ring obstructions from the anatomical, physiological, pathological, and therapeutic standpoints might go far toward reducing the number of fatalities for which they are responsible.

In the hope of throwing further light upon this subject, I shall give herein a report of my own experience with ring dystocias within the past several years. At the meeting of the Southern Medical Association in Dallas, Texas, November, 1925, I discussed before the obstetrical section my findings from research and practice through the years 1919 to 1925, inclusive. The cases upon which the present report is based have been observed since that time. They were, moreover, taken from my private practice. I make a point of this statement because I feel that private cases afford the most exact information. In the department for teaching of the University of Tennessee we have delivered over twenty thousand infants throughout the same period of years. This work, on the whole, has been done by a number of persons, and, although the cases have been studied and evaluated, it is apparent that, in the circumstances, records of such rarely recognized conditions as uterine rings could hardly be accepted as accurate. My private patients, on the other hand, have received my personal attention.

Read before the New York Lying-In Society, New York, April 8, 1937.

According to my observations, retraction and contraction rings are by no means identical. The uterine retraction ring is a definite entity. It has certain distinguishing features.

1. The retraction ring is always at the juncture of the upper and lower uterine segments, in the annular layer of the submucous coat.
2. It is always palpable behind the symphysis at this juncture.
3. The body of the uterus is tense and painful on pressure so long as the ring persists.
4. The ring is found more often in long labors caused by malposition of the fetus.
5. The carbon dioxide combining power of the blood usually is low.
6. The ring is relaxed only by analgesia and anesthesia, and relief of acidosis when this condition exists.
7. Disproportion is often present.

Contraction ring, on the other hand, is characterized by the following:

1. It can take place at any point of the uterine musculature, since the active fibers run in both the circular and longitudinal directions.
2. The ring can occur after delivery if the placenta is retained.
3. The uterine body is not tense above nor below the ring, hence there is no pain on pressure.
4. Contraction ring is not especially related to malposition of the fetus.
5. All contraction rings are physiologic; they become obstructive only when some of the factors which produce the retraction ring are present.
6. Contraction rings are easily relaxed by mild analgesia and anesthesia.
7. There is no disproportion.

The validity of these observations can easily be appreciated by a study of the muscular structure of the uterus in pregnancy. The uterus is composed of three muscular layers of tissue: the

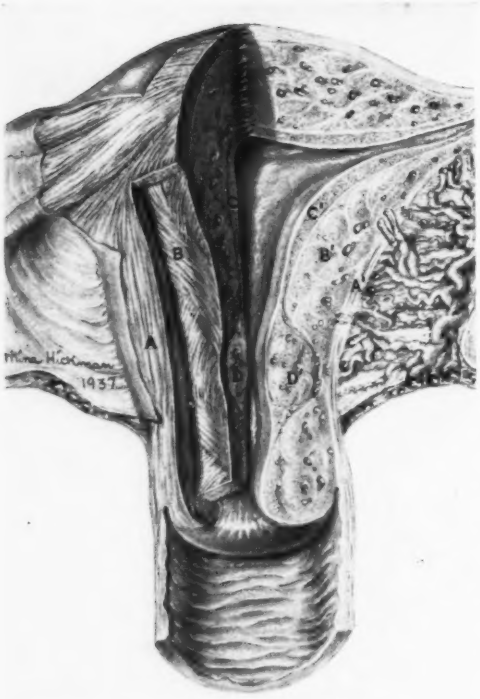

Fig. 1. Schematic drawing showing the muscular layers of the pregnant uterus. *A*, Longitudinal muscle and the outer coat; *B*, central muscular layer composed chiefly of spiral and longitudinal fibers; *C*, the submucous coat; *D*, the annular layer of the submucous coat where the retraction ring always occurs; *A'*, *B'*, *C'*, and *D'*, the layers from a different view.

submucosum, the stratum vasculare, and the subserosum. There is no sharp demarcation between the layers of the uterine wall as is found in the walls of the intestine; in the uterus the several layers of the myometrium interlace.

In the thin layer of muscle just under the serosa the fibers run principally in a longitudinal direction. At the juncture of the fornices with the vagina, these fibers continue on to form part of the muscular wall of that organ. Between these longitudinal fibers are the transverse fibers which are active in contraction ring formation.

The fibers of the middle layer, which run radially, constitute two-thirds of the entire thickness of the wall. Because of its thickness and the numerous blood vessels which it contains, the middle layer is known as the stratum vasculare. Its outer fibers, adjacent to the stratum subserosum, are sometimes described as a distinct layer, the stratum supravasculare. Aside from the fact that the muscles of this outer layer of the vascular area entwine about the blood vessels in a sort of figure eight arrangement, no good reason exists for the special designation.

The innermost layer, or stratum submucosum, lies, as its name suggests, under the endometrium. This layer contains a large number of circular and oblique fibers which, at the fundus, form the muscular rings around that portion of the tube and continue into the tube to form its circular layer. Below, just above the internal os, is a thicker segment of annular fibers, and it is at this point that the retraction ring is encountered.

An illustrative drawing of the musculature of the uterus is shown in Figure 1.

During pregnancy, the normal structures undergo profound anatomical changes. The individual muscle fibers are greatly augmented in number—not by a process of division of elements already present, but by conversion of non-muscular into muscular elements. At the same time, the fibers increase at least ten times in size, swelling from 40 to 500 micra in length. The nature of the physiological changes, if any occur, can only be conjectured at the present time. It is unlikely that such enormous changes in anatomy would not be accompanied by equally important changes in physiology.

In the anatomical distribution of the muscular fibers of the uterus lies the mechanical basis for the waves of contraction that sweep over the organ during parturition. These waves begin at the fundus and involve, for the most part, the three layers, continuing to do so until the uterine contents engage the cervix; the circular fibers then contract more vigorously in the wake of the fetus. Normally, the circular contractions produce rings of constriction which are alternately loosened by the retraction of the longitudinal fibers. By this combined effort the fetus is pushed toward the outlet, while coincidentally the uterine rings are pulled back and slipped over the fetus in much the same manner as the snake pulls himself around his prey.

It is conceivable that failure of the longitudinal fibers to loosen these rings of constriction can throw the entire uterus into a state of contraction, thus preventing its contents from moving outward. As has been stated, constrictions of this type may occur at any point (Fig. 2). They are initiated by some of the same factors which produce retraction rings, but may be easily relaxed by mild analgesia and anesthesia. However, when the longitudinal fibers fail to loosen the segment of circular fibers composing the

TABLE I

Year	Number cases	Number rings	Para		Position			Rotat.		Delivery		Forceps	
					Post.		Ant.			Nor.	Ver.		
			Prim.	Mult.	Lt.	Rt.		Man.	For.			Mid.	Low
1925	70	3	3										
1926	278	7	5	2	2	1	3				3	1	1
1927	197	6	4	2	3	2	1					3	2
1928	273	5	4	1	2	1	2	1			4		1
1929	319	6	2	4	2		2			1	1	2	
1930	329	8	6	2	3	5		2	1		2	3	3
Total	1466	35	24	11	12	9	8	3	1	1	10	9	7

Analgesia: morphine, scopolamine, and Gwathmey solution.
Mortality: fetal, 4 (1.14%), maternal, 0.

TABLE II

Year	Number cases	Number rings	Para		Position			Rotat.		Delivery		Forceps	
					Post.		Ant.			Nor.	Ver.		
			Prim.	Mult.	Lt.	Rt.		Man.	For.			Mid.	Low
1931	277	18	14	4	8	7	3	2	10	1	2	11	4
1932	239	9	5	4	2	7				2	1	4	2
1933	258	8	6	2	3	3	2			1	2	3	2
1934	258	6	5	1	5	1	1	1	3	1		4	1
1935	243	4	2	2	3	1				1		2	1
1936	246	0											
Total	1521	45	32	13	21	19	6	3	13	6	5	24	10

Analgesia, 1931–1935: morphine, scopolamine, and sodium amytal.
Analgesia, 1936: morphine, scopolamine, and nembutal.
Mortality: fetal, 3 (0.6%); maternal, 0.

annular layer of the submucosum, which is known as the physiological retraction ring, the other layers are engaged in the constriction, the ring becomes thickened and rigid, causing obstruction, the cervix relaxes, the uterus above the ring becomes tense, and the abdomen is painful upon pressure. The physiological retraction ring then becomes pathological (Fig. 3).

This pathological ring may obstruct with varying degrees of force. In the most severe form, every muscle fiber of the uterus is contracted and retracted, allowing no relaxation and producing in the uterus a condition of tetany. The tenseness may be so acute and so forceful as to compress the blood vessels supplying the fetus and lead to its asphyxiation. Occasionally, one sees a rupture of the lower uterine segment from overstretching and thinning of the walls (Fig. 4). Microscopic sections have shown all the uterine muscle fibers retracted, that is, shortened and thickened, and the number, particularly the spiral and transverse fibers, markedly increased. Rudolph described this development as a permanent, non-reversible constriction ring, which does not relax under anesthesia or drugs, or even after death. We have had 2 cases of this type, and an additional 2 have been observed by my associates. White, Phillips, Carson, Hannah and Massey, and others, have reported similar cases.

ETIOLOGY

Bearing in mind the anatomical structure of the uterus, it would seem that there are four major causes of retraction ring dystocia. A number of minor factors may contribute, but in the final analysis these are basic: (1) malposition of the fetus, (2) early rupture of the membranes, (3) disproportion, (4) the response of the musculature to an abnormal blood chemistry.

If labor is severe from any cause, the normal chemistry of the blood may be altered; the carbon dioxide combining power is reduced, and

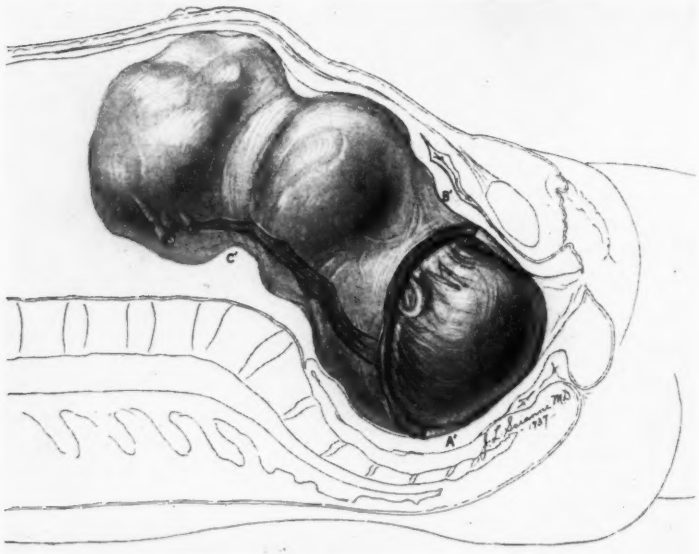

Fig. 2. *A'*, Full dilatation; *B'*, retraction ring; *C'*, contraction.

acidosis supervenes. Several years ago we observed that a number of our ward patients, after being in labor for more than 18 hours, suffered shock, and a few succumbed suddenly from the anesthetic. To our surprise, we discovered that the anesthetist had ordered nothing to be given by mouth during the second stage of labor, in order to prevent nausea in anesthesia. As a consequence, the carbon dioxide combining power of the blood was found to be excessively low. It was these patients who suffered from ring formation.

Alkalosis, also, may influence the development of pathological retraction ring, but in our experience this condition has been so rare as to be regarded as an almost negligible possibility.

DIAGNOSIS

In making a diagnosis of retraction ring dystocia, the following signs are to be considered:

1. Prolonged labor, that is, from 12 to 36 hours.

2. Malposition and slight advancement of the fetus, the head or presenting part within the dilated cervix.

3. The appearance of a sulcus across the lower abdomen above the symphysis pubis, at a level corresponding to the peritoneal attachment where the coronary vein crosses body of uterus.

4. Tenseness of the uterine body above the sulcus, and pain on palpation of the abdomen.

5. On vaginal examination, a freely movable presenting part, and a cervix dilated sufficiently to permit passage of the examining hand beyond the portion where the ring is found.

6. Low carbon dioxide combining power of the blood.

TREATMENT

The most important part of any medical procedure is treatment. In these cases, the treatment consists of both preventive and curative measures. We believe that the great majority of uterine ring retractions can be prevented. Upon reviewing our cases since 1925, we found that the number of rings and long labors followed very closely the manner in which the patient was treated. Since we have had no retraction ring dystocias during the past 12 months, we feel justified in concluding that our present method is successful. This method is given herein.

When the patient in labor arrives at the hospital, following the usual preparation, she is examined both abdominally and vaginally. She then receives a rectal injection of 3 to 6 grains of one of the barbiturates. If this brings about cessation of pain and sleep during the intervals, nothing further is given. When she begins to awaken and complain, morphine sulphate, $\frac{1}{6}$

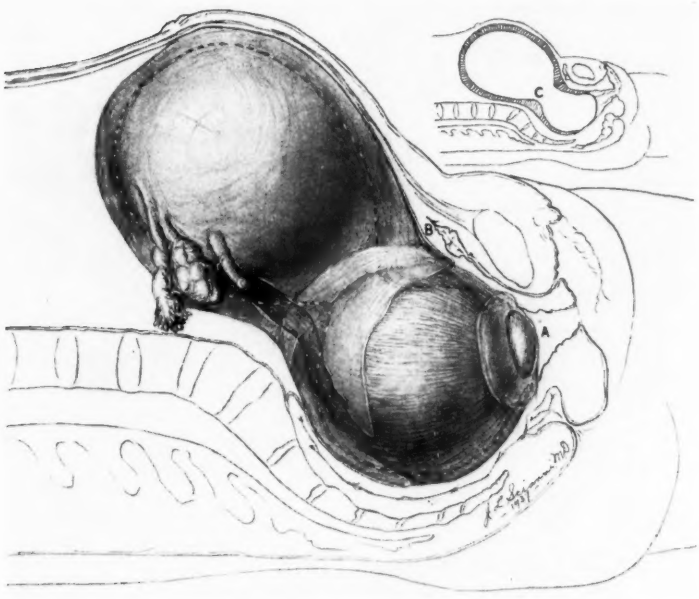

Fig. 3. *A*, Dilatation; *B*, retraction ring; *C*, insert, where retraction occurs.

grain, and scopolamine 1/200 grain is given hypodermically. A smaller portion of this, alternating with 1.5 to 3 grains of one of the barbiturates, with scopolamine 1/300 grain is administered thereafter as necessary. Fluids are given; if labor is prolonged, they are injected intravenously. Analgesia must be complete if good results are expected. It does not prolong, but, rather, shortens labor, and it does not affect the baby. By this method, the patient can be carried along for many hours in comparative comfort.

If the foregoing measures fail to prevent the development of a ring, or if a ring is already present when the patient is examined, a test is made for the carbon dioxide combining power of the blood. When this is found to be low, an intravenous injection of 1 to 2 per cent sodium bicarbonate is given. The analgesia is continued. If the ring persists when the patient is ready for delivery, 6 minims of adrenalin solution are given hypodermically for relaxation, and ether is administered. It is essential that both analgesia and anesthesia be allowed to take full effect before an attempt is made to deliver. If, in spite of analgesics, adrenalin, anesthetic, and sodium bicarbonate, the uterine retraction is not relaxed, tetany develops and the baby shows signs of distress, a cesarean section is indicated.

Since this treatment of sodium bicarbonate was instituted, about 2 years ago, we have not had the opportunity of giving it an extensive trial. In 2 of the 6 cases in which it was followed, delivery was made with low forceps, and in 2 delivery was spontaneous. In these 4, the ring disappeared entirely, and the uterus was slightly relaxed. In the 2 remaining cases the treatment had no effect.

Of vital importance is the correction of the acidosis or alkalosis before inducing profound anesthesia to relax the ring. We caused the

Fig. 4. Ruptured uterus. Protrusion of extremity from the os and rupture below. Retraction ring at *A*.

Fig. 5. Uterine retraction ring. Sulcus above the symphysis.

death of several dogs before realizing that failure to correct the imbalanced chemical ratio before giving the anesthetic was responsible. In the past, I have known fatalities to occur, no doubt from this combination, which were attributed to cardiac thrombosis or embolus.

Our reasons for using sodium bicarbonate in preference to glucose or Hartmann's solution might well be explained. In carrying out some experiments upon dogs with acidosis, we found sodium bicarbonate much more effective; in fact, we produced an extreme acidosis in dogs by giving 2 per cent lactic acid solution. The normal ratio was restored by the use of a 2 per cent solution of sodium bicarbonate.

In this connection, I should like to state that sodium bicarbonate should never be given intravenously to a diabetic. Further, glucose and sodium bicarbonate should not be given together; we killed 5 dogs with this combination.

Neglect of early treatment by proper analgesia and the prevention of acidosis or alkalosis may lead to the development of a severe type of retraction ring. The following case, which was one of a series recently reported by an essayist, is a typical example of the effect of inactive treatment.

TABLE III

Average labor: 22½ hours	
Infant mortality, per cent	0.87
Operative incidence, per cent	91.2
Positions not listed in previous tables:	
Breech	2
Face	1
Brow	1
Shoulder	1
Cause of stillbirths:	
Cord around neck and body	1
Ring contracted on baby's neck (breech delivery)	1
Face presentation	1
Birth injury	1
Prolapsed cord	1
Another doctor attempted delivery	1
Ring on baby's head; died later, cerebral symptoms	1

Fig. 6. Cesarean section for unrelaxed retraction ring. Uterine tetany.

The patient was a primipara, aged 20 years. Labor began September 4, at 12:00 o'clock noon. The cervix was partially effaced. The right occiput was in the anterior position. On September 5, the cervix was dilated to 6 or 7 centimeters. By September 6 the cervical dilatation had not increased, and routine treatment for exhaustion was given. The acetone test was negative. At 7:00 o'clock on the morning of September 7 the patient was showing the strain of labor; the cervix was dilated to 8 centimeters. Intra-uterine examination revealed a ring around the neck of the fetus. Morphine and scopolamine were given, as well as an intravenous injection of glucose. At 7:57 o'clock in the evening, epinephrine was administered, and at 8:30 a spontaneous delivery occurred.

It is my opinion that, if efficient analgesia had been given early in this case, labor would have terminated at the end of 2 days, rather than have been prolonged through the 4 days.

METHOD OF DELIVERY

Several years ago we regarded podalic version under deep anesthesia as the best method of delivery in retraction ring dystocia. In analyzing our cases from 1925 to 1930, we found 10 versions, 9 midforceps, and 7 low forceps (Table I). From 1931 to 1936 there were only 5 versions, 24 midforceps, and 10 low forceps (Table II). The fetal death rate was 1.14 per cent in the first group, and 0.6 per cent in the second. There

TABLE IV

Delivery		
Forceps		
Prophylactic		1
High		1
Mid		2
Version		8
Breech		4
Embryotomy		1
Total Cases		17
	Cases	Per cent
Infant mortality	3	17.6
Cerebral injury	3	17.6
Maternal mortality	0	
Operative incidence	16	94.1

JAMES R. REINBERGER, M.D.

was no maternal mortality in either. In the light of our present knowledge, an attempt to turn a fetus in a tense uterus is a procedure which is open to criticism.

A statistical résumé of this study of 2,987 private patients is given in Table III.

One of my associates, Dr. James R. Reinberger, has tabulated a report of 17 cases from his private practice, which is presented in Table IV. Although the infant mortality of 17.6 per cent in his cases seems high, when one considers the number of cases and the fact that the series covers a period of years during which there was no well known routine treatment, the result is good. His operative incidence was 94.1 per cent. Ours was 91.2 per cent. In his series, also, there were no maternal deaths.

In closing, I should like to present two photographs loaned by Dr. Raymond Wallace, of our staff. These show an interesting case of tetany uteri, caused by a retraction ring which failed to relax under analgesia and sodium bicarbonate. A section was performed, and both mother and baby survived. The rather high position of the sulcus, as shown in Figure 5, is due to the manner of photographing. In Figure 6, the tetanoid condition of the uterus is clearly apparent.

SUMMARY

1. Retraction rings are found, as a rule, in long labors.

2. Contraction rings are physiological, but become pathological under some of the conditions which produce retraction rings.

3. Retraction rings always occur at the juncture of the upper and lower uterine segments: the annular layer of the submucous coat.

4. Tetany uteri develops when the force of the retraction is exaggerated.

5. Retraction ring may be prevented by effecting early analgesia and, when indicated, instituting measures to combat acidosis or alkalosis.

6. We have found a combination of the barbiturates, morphine, and scopolamine affords the most satisfactory analgesia.

7. Labor is shortened by proper analgesia, and the mother and baby suffer no harm.

8. The carbon dioxide content of the blood usually is low when retraction ring is present.

9. Sodium bicarbonate will restore a low carbon dioxide content to normal.

10. Lactic acid will correct an excessive alkali ratio of the blood.

11. We have never found cesarean section necessary in ring retraction except in the presence of uterine tetany.

12. Fetal mortality from ring dystocias should be approximately 10 per cent. There should be no maternal mortality.

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AMBULATORY OPERATIVE TREATMENT OF ANORECTAL PATHOLOGICAL CONDITIONS

194 Consecutive Operations Performed Under Local Anesthesia of Prolonged Duration

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J. GORDON RENNIE, A.B., M.D., Richmond, Virginia

THE pathological entities of chronic fissures and cryptitis, hypertrophied papillæ, simple uncomplicated fistulas of the anus, and single internal hemorrhoids are amenable to ambulatory, operative treatment in selected cases.

There is some nervous and physical strain associated with this form of treatment. Patients who are highly nervous, and those who are in poor physical condition should not be subjected to this additional emotional trauma. The more affluent patients will prefer to be admitted to the hospital for any operative procedure.

By operating upon and keeping these patients ambulatory, we have been able to save them their hospital expenses, and in many cases have reduced their economic loss by returning them to work earlier than would have been possible had they been admitted to the hospital for the same operations.

We have included in this series (up to April 19, 1937), 194 operations performed under anesthesia in oil, on 181 patients. Of these 194 operations, there are 124 for fissure, 34 for fistula, 10 for internal hemorrhoids, 4 for chronic cryptitis, 12 for chronic papillitis, 6 for combined cryptitis and papillitis, and 4 for unhealed postoperative wounds.

From a practical standpoint, typical chronic fissures and the chronic cryptitis lesions require the same treatment, namely, excision, and we have included both entities in our series under the caption of "fissures."

FISSURE OF THE ANUS

A true fissure of the anus begins as a linear laceration in the epithelium just distal to the mucocutaneous line (Figs. 3 and 7). The lesion most commonly results from the passage of hard fecal matter over the resistant pectinate line. Less frequently it is due to overstretching of the anus at childbirth. The presence of large internal hemorrhoids and particularly of hypertrophied anal papillæ also contribute materially to the production of fissures. These structures exert their influence mechanically through the variation of stress as the stool passes by these masses at the pectinate line.

Symptoms. A fissure is one of the most painful anal lesions with which we have to deal. The anal canal distal to the mucocutaneous line abounds in sensory nerve terminals; hence it is extremely sensitive to contact with stool or other foreign objects. The most characteristic symptom of a fissure is a sharp, knife-like pain during the passage of a hard stool, followed by a dull, aching pain for a few hours. In the chronic form there is usually a history of recurrent attacks of sharp pain at stool when the patient is constipated. These attacks last for periods of days to weeks and recur at intervals of weeks to months. The pain is frequently relieved when the stool becomes soft. The fissure not operated upon frequently heals, and is broken down subsequently by the passage of a hard stool. Because of the pain the patient is afraid to move his bowels, and increased constipation is the rule. The passage of hard fecal matter further traumatizes the lesion, sphincter spasm increases, and a vicious cycle is established.

Examination. The fissure can be seen by properly retracting the peri-anal folds (Fig. 3) at the anterior or posterior commissure, where nearly all of these lesions occur.

In a nervous patient with an active fissure, to complete the examination causes great pain and actually serves no useful purpose. It is far better to complete the instrumental part of the examination after the pain from the fissure has been relieved by appropriate surgical means. Every patient, before he is discharged, should have a sigmoidoscopic examination to rule out malignancy.

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The local application for 10 minutes of a pledget of cotton containing 25 per cent cocaine or other topical anesthetic agent usually will provide sufficient anesthesia to permit a gentle digital examination but not enough for a complete, painless instrumental investigation. The injection of a local anesthetic (preferably in oil) underneath the fissure usually is not necessary, although there is no objection to this procedure if it seems desirable to rule out malignancy before proceeding with surgical treatment.

The acute fissure of the anus is superficial, presents no appreciable induration, and is not accompanied by the so called "sentinel pile." There is usually marked spasm of the external sphincter ani.

The chronic fissure presents a more marked lesion associated with greater fibrosis (Figs. 7 and 8). Through the examining finger the surgeon senses more or less induration in the base of the lesion. Spasm of the sphincter varies from slight to marked.

The permanent cure of chronic fissures of the anus almost invariably requires operation, although some acute fissures can be treated successfully without operation mainly by measures to soften the stool. However, since we are dealing with the operative treatment of fissures, we shall reserve discussion of the treatment of acute fissures, and confine our remarks to the operative handling of chronic pathology.

A fibrous tissue mass or so called "sentinel pile" (Figs. 3, 7, and 8) usually overhangs the outermost extent of the chronic fissure or ulcer. It is not a true pile but results from chronic irritation following prolonged infection in the fissure or crypt.

ANAL PAPILLA

In addition to the "sentinel pile" there is frequently associated with the fissure an enlarged anal papilla or fibroma of the anal canal at the upper limit of the fissure (Figs. 3, 7, and 8). This is an enlargement of a normal structure, as the result of chronic infection at its base and repeated trauma from the passage of hard stool over the resistant pectinate line. This structure acts like a foreign body. At stool it is forced downward and insinuates itself into the fissure. It thus causes increased pain and mechanically prevents healing. Not infrequently it becomes long enough to protrude at the anal orifice.

CHRONIC CRYPTITIS, ABSCESSES AND FISTULAS OF THE ANUS

It is easy to confuse the typical fissure just outside the pectinate line with a small ulcer which forms locally as a result of infection in a crypt of Morgagni or the adjacent vestigial anal gland (7). The pathology is different fundamentally. The fissure is located distal to the mucosal margin and primarily involves transitional epithelium. On the other hand, an ulcer resulting from an infected crypt is found to involve the mucosa just above the pectinate line, as well as the crypt itself beneath the shelving edge of transitional epithelium at the mucocutaneous margin. A "sentinel pile" often overhangs the chronically infected crypt.

In many cases, the fissure or infected crypt is associated with considerable active infection. The location of the fissure or crypt deep in the anal canal beneath the "sentinel pile" and between the folds of peri-anal skin tends to prevent free egress of infected discharge. The infection may spread upward to form a perirectal abscess in the submucosal space. Much more often, however, the infection spreads downward beneath the skin to form a subcutaneous, peri-anal abscess, which ruptures through the skin to form an associated fistula. This fistula is usually superficial and its external opening is most often located near the base of the fissure or "sentinel pile". There may be multiple external openings at varying distances from the pectinate line, due to extension of the initial inflammatory reaction, through liquefaction of the peri-anal fatty tissue. Rarely does the infection spread from a fissure or infected crypt into the space below and lateral to the levator ani to form a true ischiorectal abscess.

In selecting a fistula for operation in an ambulatory patient, one must be extremely cautious. Very frequently, it is most difficult to determine before operation the extent of the fistulous ramifications. One should select for this type of operation only those simple, uncomplicated cases in which the fistula is superficial and through which a probe can be easily passed.

INTERNAL HEMORRHOIDS

A satisfactory diagnosis of internal hemorrhoids can be made only by viewing them through the anoscope. Palpation is of no definite value. Except in extenuating circumstances, one should operate upon and keep ambulatory, only those patients who have one enlarged, protruding internal hemorrhoid. The others with more extensive pathology should be operated upon in the hospital.

OPERATIVE TREATMENT

The majority of patients suffering from anal disease present themselves for treatment after the lesion has become chronic. The chronic, well

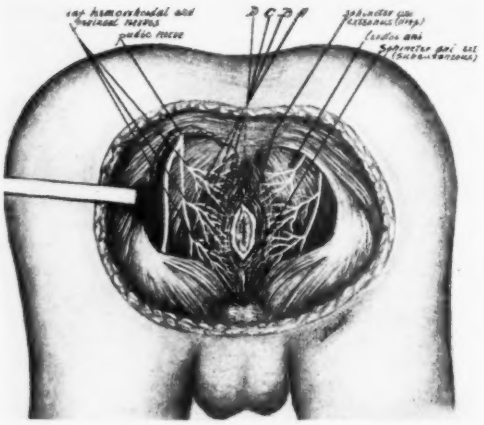

Fig. 1. Anatomical structures of the anal region: *ABCD* show the subcutaneous injection area on the left for posterior or lateral lesions. When this is repeated on the right, peri-anal, dermal anesthesia is produced for the posterior two-thirds of the anal region. A similar injection in the right and left anterior quadrants produces complete cutaneous anesthesia for anterior pathology. A combination of these injections anesthetizes the complete cutaneous peri-anal region.

established lesion requires operation. Palliative treatment is of little real value.

Pre-operative preparation. The patient takes a soap suds enema and eats a light meal before he comes for operation. Our patients usually are not given any pre-operative sedation, although there is no real objection to 3 grains of sodium amytal or other similar medication the night before and again 1 hour preceding the operation.

Position of the patient. Any position which is convenient and comfortable for the operator and patient is quite satisfactory. We prefer the knee chest position, although the Sim's posture is very satisfactory.

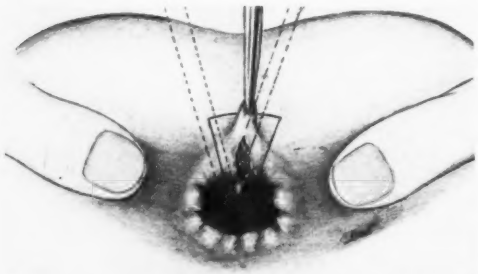

Fig. 3. Exposure of the fissure and enlarged anal papilla after relaxation of the sphincter. Triangular lines show the area of excision of the skin, sentinel pile, fissure and papilla.

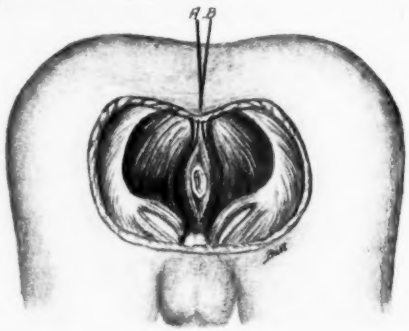

Fig. 2. Injection of the external sphincter ani. With the finger in the anal canal, the anesthetic material is laid down in the subcutaneous sphincter in the region of the dotted line. The needle is then passed in the same peri-anal direction but in a deeper plane to inject the deeper and more extensive portion of the external sphincter ani. None is placed in the ischio-rectal fossa.

Selection of anesthetic. Our principal desire in the selection of an anesthetic for anal operations is to establish instantaneous and complete anesthesia, with prolonged effect to relieve the pain for at least 10 to 14 days. After this time has elapsed, granulation tissue has covered the sensory nerve terminals, and there is no longer need for analgesia.

The effect of water soluble anesthetics—novocain, for example—is of too short duration to provide the desired effect. The use of anesthetics in oil provides quite a satisfactory means of eliminating or greatly reducing pain and tenderness after operations for chronic anorectal pathology. Yeomans, Gorsch, and Mathesheimer in 1927 introduced the use of anesthetics in oil, and thereby made an exceedingly important contribution to proctologic surgery. Since that time, this method of administering anesthesia has been improved, and used in various forms throughout the world.

The effect of this type of administration is instantaneous and complete. The duration of the anesthesia is difficult to determine becaue of the difference in the reactions of patients. Conservatively, the duration of good analgesia may be said to be 2 to 3 weeks.

The oil should not be injected into the epidermis, for an oil in the skin will cause a pressure necrosis. In the absence of frank infection, it may be introduced safely into the subcutaneous or deeper structures. There should be no pooling of the oil; this is assured by constant progress of the needle as the oil is injected.

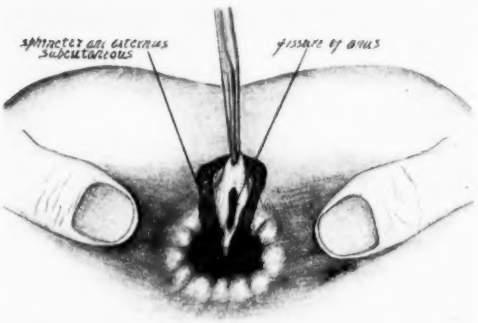

Fig. 4. Skin incision extends above the mucocutaneous line to include the fissure, subfissure fibrosis, sentinel pile, and enlarged papilla.

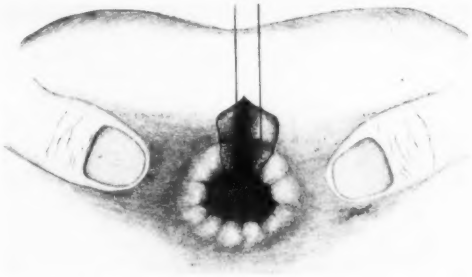

Fig. 5. After removal of the fissure and its concomitants, the subcutaneous, external sphincter is incised. The incision extends into the deeper portion of the external sphincter. Sufficient skin is removed to permit free escape of the serosanguineous discharge. Short strips of plain gauze packing are laid into the entire wound.

We have used benacol, anucaine, nupercaine, butecaine, and neothesol, as anesthetic agents. We have had the most satisfactory results with neothesol, the component parts of which are:

	Parts
Procaine base	1
Methyl methylene para amino phenylformate	2
Hydroxbenzocarbinol	5
Refined French almond oil—q.s.ad.	

Following the use of this formula we have seen none of the redness and severe itching which has been noted with some of the other formulas. The postoperative discomfort and pain, and particularly the wound necroses, have been lessened.

TECHNIQUE OF INJECTION OF ANESTHETIC IN OIL

A dry 20 cubic centimeter syringe is used. The anesthetic material is drawn into the syringe through a large caliber needle (gauge 15). This needle is replaced by one of much smaller bore (gauge 20), and of 2 to 2½ inches in length.

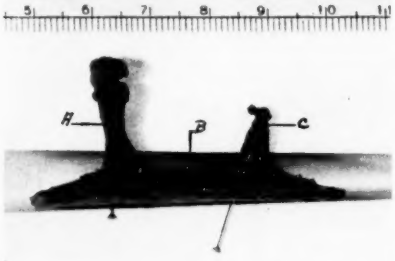

Fig. 6. *A*, Hypertrophied anal papilla; *B*, fissure of the anus; *C*, sentinel pile.

The peri-anal skin is shaved. The anus and surrounding skin are cleansed with alcohol. The anal canal and rectal ampulla are not prepared other than with the enema. The skin through which the needle is to be introduced is prepared with tincture of iodine.

At the point of election for the introduction of the anesthetic, a novocain wheal is made with a hypodermic needle. The larger needle is introduced through this wheal. By passing this needle slowly in a circum-anal direction in the subcutaneous space, complete peri-anal anesthesia of

Fig. 7. *A*, Sentinel pile or fibrous mass; *B*, typical fissure; *C*, hypertrophied papilla; *D*, mucocutaneous line.

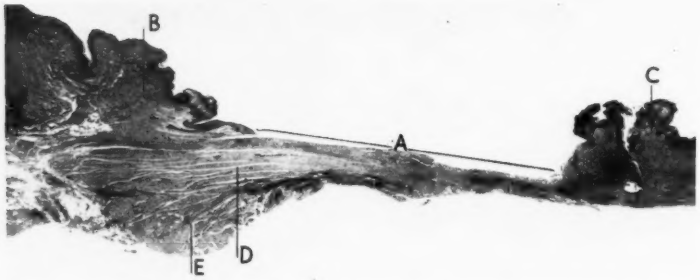

Fig. 8. Low power of a typical fissure, *A*, is seen between the sentinel pile, *B*, and a small anal papilla, *C*. The longitudinal smooth muscle bands of the intestine are visible at *D* and the circular muscle fibers at *E*.

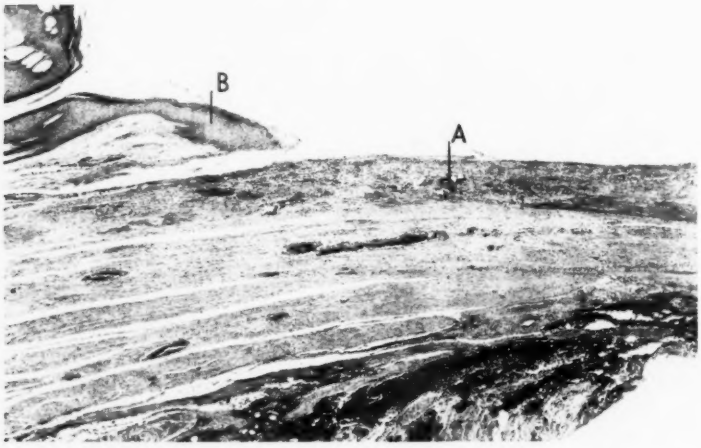

Fig. 9. High power of the fissure as shown in Figure 8, presenting the fibrous tissue and cellular infiltration, *A*, underneath the fissure, with the squamous epithelium of the sentinel pile, *B*.

the skin can be produced (Fig. 1). Great care must be exercised to prevent intradermal deposit of the oil, which will produce necrosis.

If the lesion is located only in the posterior region, the anesthetic agent can be introduced through one skin puncture about 1 to 1½ inches posterior to the anal ring. If it is located anteriorly it is desirable to introduce the anesthetic material through the skin in either or both the right and left anterior quadrants about 1 to 1½ inches from the anal verge. In this way more complete and satisfactory anesthesia can be produced than through one puncture wound.

If hemorrhoidectomy or excision of multiple crypts is to be done, the posterior and the two anterior injections should be combined.

After the anesthetic material has been introduced into the subcutaneous space around the anus, the index finger is introduced into the anal canal, the needle is passed on either side into the subcutaneous portion of the external sphincter ani, and this structure is thus completely injected. Then the deeper and more extensive part of the external sphincter is infiltrated with the oil (Fig. 2). Should this deeper portion, including the puborectalis, be too extensively infiltrated, a temporary incontinence may result. If this should occur, it is of little consequence, as the sphincter tone returns in about 10 days, when the major portion of the anesthetic effect has disappeared.

If the needle is passed deep to, and somewhat above, the subcutaneous sphincter, the sub-

mucosal region can thus be injected underneath the local lesion. Except when the lesion is extensive, it is not necessary to inject the entire submucosal region. It is entirely unnecessary and undesirable to inject into the ischiorectal space. In many of our earlier cases we injected this space without untoward effect, yet the satisfactory results with perfect anesthesia in the absence of this injection, convinced us that it was unnecessary. The elimination of this step has removed the possibility of a deep abscess.

Amount of anesthetic agent. In general, 15 to 20 cubic centimeters of the oil anesthetic agent is adequate for most anal operations. However, 25 cubic centimeters may be required for hemorrhoidectomy. Although the amount of anesthetic material will vary with the extent and location of the pathology, the following general distribution may be used in the case of a fissure of the anus:

3 c.cm. subcutaneously on each side.
3 c.cm. in the subcutaneous and deep external sphincter on each side.
3 c.cm. underneath and around the local lesion.

OPERATIVE PROCEDURE

Fissure or infected crypt. An Allis clamp is placed in the lesion, and a hemostat is applied to the mucosa well above the pectinate line in the region of the local lesion to prevent retraction of the incised edge. The incision is made to include the sentinel pile, the fissure or crypt and the papilla above (Fig. 3). This incision is made generally in the shape of a triangle with its apex within the anal canal. The skin excision is made sufficiently wide externally to permit free egress of the serosanguineous discharge. If this excision is inadequate, the outer part of the wound will heal too fast, and the deeper portion will be very slow in healing or may even fail to heal.

Great care should be exercised to remove any enlarged papilla above or adjacent to the local lesion, as its presence will mechanically prevent healing and necessitate a second operation.

When the external skin incision is made, the skin edge is grasped and dissected free from the subcutaneous sphincter underneath, thus removing the fissure or crypt with the underlying fibrosis (Fig. 4). The dissection is carried to a point well above the pectinate line, where the pedicle is ligated for complete hemostasis. The subcutaneous, as well as part of the deep, portion of the external sphincter ani is incised, to produce satisfactory relaxation of the anal canal and to promote proper healing (Fig. 5).

It is particularly important not to incise completely through the deep portion of the external sphincter ani. Permanent incontinence will not result if a portion of the true anal canal, including the innermost margin of the levator ani (puborectalis), is left intact. If the entire anal canal is incised, partial incontinence may result.

Plain packing is placed in the wound, preferably in short strips of ½ inch width. A pad of gauze is then placed over the anus, and the buttocks are pulled tightly together with adhesive for hemostatic purposes.

Postoperative care. At the end of 48 hours (second day), the external padding is removed. The packing is not disturbed because bleeding is likely to occur if it is removed at this time.

The patient is instructed to take 2 ounces of milk of magnesia on the morning of the second day, to be followed by a soap suds enema later in the same day if he has not had a satisfactory movement. He is also instructed to take hot sitz baths for 20 minutes, twice a day. The water should be gradually made hot to avoid weakness and should be cooled off at the end of the bath to prevent the patient from taking a cold.

The packing is permitted to come away with the first or second stool. If it has not been expelled by the end of the third or fourth day, it is removed. The danger of hemorrhage incidental to pulling the packing away has passed.

During the first 48 hours after the operation, the patient is given a light diet of tea, toast, milk, cereal, and eggs. After 48 hours, a regular diet is prescribed. If a movement becomes necessary during the first or second day after operation, the patient is told to take off only the outside dressing. The packing is usually not expelled and we have not seen any hemorrhage as a result of a movement prior to 48 hours. Sufficient codeine is administered to eliminate any pain.

After the packing has been removed and the bowels are functioning adequately, it is important to dress the wound frequently, say every second or third day, to be sure it closes from within and not from the adherence of the raw surfaces. This can be most easily done by passing the index finger into the anal canal and bringing it out through the depth of the wound, which continues anesthetized for some 2 to 3 weeks after the operation.

Fistula of the anus. A probe is passed through the fistula, or the tract is injected with methylene blue. The anesthetic material is injected around the local lesion, and not throughout the peri-anal region, as would be required in a more extensive operation. The skin overlying the tract is excised widely so as to permit free drainage. Great care must be exercised to remove, if possible, the internal opening, which is usually to be found in an adja-

cent crypt of Morgagni. Although desirable, it is not necessary to excise the entire circumference of the tract, as the granulation tissue will be covered with epithelium if the tract is laid open and adequate drainage is established. The insertion of packing and the postoperative treatment is exactly the same as for the fissure of the anus.

Papilla, hypertrophied. The anesthetic agent is injected only underneath the immediate lesion and local excision is performed. It is usually not necessary to incise the subcutaneous sphincter except if spasm is marked. The insertion of packing and postoperative care are the same as for fissure.

Internal hemorrhoid. The anesthetic agent is introduced as described under "fissure." The internal hemorrhoid, together with its external counterpart, is dissected down to a pedicle of mucosa, which is ligated. Hemostasis is established; plain packing is inserted in short strips. Postoperative care is that described under "Fissure."

ANALYSIS OF CASES

A total of 211 consecutive operations were performed on 181 patients. Most of these were done in the Vanderbilt Clinic by, or under the direct supervision of, the senior author. A few operations were performed on private patients. In 194 operations the anesthetic was injected in oil. In the 17 remaining cases 2 were given spinal anesthesia; 6, novocain; 3 had no anesthetic given, and 6 were given a general anesthetic. Twenty-two of the 181 patients required a total of 50 operations, and in 34 of these the anesthetic was given in oil.

Sex. The female seems to be more susceptible to this general type of pathology: 117, or 64.6 per cent of the 181 patients were females; 64, or 35.4 per cent were males.

Age. The average age of the 181 patients on whom these operations were performed was 39.8 years. The average age of the males, 42.2 years, was slightly above that of the females, who averaged 37.6 years. The youngest patient was 18 and the oldest 62 years.

General reactions of patients. While most of our patients have experienced no pain, others have complained of more or less pain for a few hours after the operation. We believe that incomplete initial anesthetic effect prevails when these patients complain of severe postoperative pain. Their pain is not very severe, as it is relieved by one to three doses of codeine, ½ grain, and aspirin, 5 grains. When the initial discomfort subsides, usually within 5 hours, the patient is almost invariably comfortable throughout the postoperative course.

Some of our patients, a minority, have complained of slight weakness for a few days, but all of them have remained ambulatory and have reported to the office or clinic for dressing on the second postoperative day. In the majority of instances these patients have been able to perform their essential household duties within 2 or 3 days and have resumed regular work within a week.

Fissures. Of the 194 operations which we considered it safe to perform in ambulatory patients, 124, or 63.9 per cent, were performed for fissures of the anus. Of this number, 107, or 86.3 per cent were in the posterior commissure. The remainder of 3, or 2.4 per cent, were located in both the anterior and posterior commissures.

Fistulas. A total of 34, or 17 per cent, of the 194 operations done under prolonged anesthesia were performed for fistulas of the anus. Twenty-nine of the patients were operated upon for primary fistulas, and the 5 remaining occurred or were discovered subsequent to one or more operations for pre-existing anal pathology. Twenty-eight, or 82.3 per cent, of these 34 were located in the posterior anal region. Five, or 14.7 per cent, were located in the anterior region of the anus. The remaining case, or 3 per cent, was in the lateral (left) wall of the anus. Two, or 5.8 per cent, of the fistulas presented upward extensions into the submucosal space, in addition to the usual subcutaneous advance and external rupture. Of the 5 fistulas which are included in the re-operated upon group, their presence is explained as follows: One was thought to have been overlooked prior to the first operation, as it presented thick walls; 1 definitely was due to retained linen ligature knots at the time of a previous operation; 1 was an old ramification from an extensive posterior fistula of the anus which had been previously operated upon twice for other extensions; the fifth one was not satisfactorily explained.

Internal hemorrhoids. Ten, or 5.1 per cent, of the 194 operations were for one or two large internal hemorrhoids. In this group we prefer to include those patients with only one large hemorrhoid.

Chronic cryptitis. Although we might easily say that almost all of the patients with fistulas were operated upon for chronic cryptitis and fistulas, we have operated upon only 4, or 2.0 per cent, of our cases for chronic cryptitis alone. These patients complained principally of anal pain and presented enlarged crypts associated with local tenderness.

Papillitis. Twelve, or 6.1 per cent, were operated upon for enlarged anal papillæ, all of which were protruding at the anus or causing discomfort at stool.

Chronic crypto-papillitis. Six, or 3 per cent, of our operations were performed for a combination of chronically enlarged crypts and papillæ.

Postoperative wounds. Four, or 2 per cent, of these operations were performed for persistent postoperative wounds, following excision for local anal pathology. We were unable to explain the persistence of these wounds except for the possible inadequate excision of skin surrounding the local lesion at the time of the previous operations. These wounds healed firmly after the additional skin was excised.

POSTOPERATIVE HEMORRHAGE

In our earlier cases we inserted considerable packing and removed it at the end of 48 hours. This resulted in bleeding in a number of the cases. Since we adopted the principle of inserting a small amount of packing in short strips and permitting this to come away with the stool, we have had almost no bleeding. Up to the time the method was changed, we experienced slight bleeding in 13 patients, moderate in 13, and marked hemorrhage in 5 cases, although not of sufficient magnitude to impair the hemoglobin balance. Packing was reinserted in 10 instances, and ligation was done in 3 patients. In only 1 instance in our series of 194 operations, was it necessary, on account of hemorrhage, to keep the patient in the overnight ward for 1 night. One other patient with slight loss of blood felt weak following operation and was confined to the overnight ward.

INFECTIONS AND REACTIONS

Following the use of the prolonged anesthesia in 194 operations, we have observed two generalized reactions. Whether these represented toxic manifestations or were emotional responses, we are unable to say.

Immediately after the injection was completed, the patients lost consciousness to regain it in a few minutes, after which they alternately responded and failed to respond every few minutes for about one-half hour. At the end of this time, consciousness was permanently regained. At the onset, the pulse became very weak and seemed to alternate with consciousness. The skin was dry at all times. There was no twitching or other localized sign. These patients were kept in the overnight ward and were discharged the next morning in a normal state. There was no subsequent reaction.

We have experienced a few untoward local reactions, but these have been so few as to be almost negligible, and certainly would not interdict the use of this type of anesthesia by an experienced surgeon. The indiscriminate use of local anesthesia by means of oil injections by inexperienced operators is certain to result in unfortunate complications.

In a few of our early cases, we noted the appearance of much redness and severe itching, with slight induration of the entire peri-anal region, beginning 2 to 5 days after the operation and lasting for 7 to 10 days. This could have been due to iodoform in the packing, but its appearance in some cases in which plain packing was used, leads us to believe it was due to the anesthetic agents. Since we have been using neothesol, we have noted none of these reactions.

In one of our earlier cases (464,518) necrosis of the skin followed the introduction of the oil into the skin around part of the wound. In one operation for fissure (282,339) a posterior, midline fistula was discovered deep to the wound after healing had progressed almost to completion. This fistula was complete, its walls were thick, and we believe that it had been overlooked as a blind, internal fistula at the time of the pre-operative examination. Excision of this fistula with patient under prolonged anesthesia resulted in complete, satisfactory healing. In another patient (M.D.) a blind external, incomplete fistula, without well formed walls was discovered deep to the fissure wound several days after the operation. We believe that this resulted from pooling of the oil. A simple incision through the intervening tissue, without anesthesia, resulted in an open wound, which healed satisfactorily in about 10 days. One other patient presented a blind external fistula, which extended upward and lateral to the anal canal wall. This was believed to be due to infection in the presence of pooling of the oil. Excision of this fistula resulted in complete healing.

In six instances there was superficial necrosis in the area of maximum deposit of the oil underneath the local lesion. The patients were not aware of these local reactions, and they were of no clinical significance.

In two of our more recent cases of fissures, in which we were operating with new anesthetics, we observed extensive, subcutaneous abscesses around the anus. These necessitated confinement of the patients to bed intermittently for a few days. Neither was admitted to the hospital. One of these required incision and drainage of the abscess. The other ruptured spontaneously. Each of these healed up satisfactorily and the patients presented no incontinence or other complaint.

In considering all of our patients operated under anesthesia, administered in oil, 12, or 6 per cent, presented necrosis of the tissue. Of this number,

only 6, or 3 per cent, were of clinical significance. In reality, only 2, or 1 per cent, of the cases could be said to present infection of clinical significance, directly and definitely attributable to the anesthetic.

CAUSES FOR RE-OPERATION

Twenty-two patients required a total of 50 operations. Only one of these was not healed when last seen. Thirty-four of these operations were performed under prolonged anesthesia; 5 under novocain, 6 under general, 2 under spinal, and 3 had no anesthetic. Of the 22 primary operations, 18 were for posterior fissures, 1 for chronic cryptitis, 2 for fistula, and 1 for external thrombosed hemorrhoid and excess skin. Seventeen patients required 2 operations each, 4 required 3 operations, and 1 necessitated 4 operations. One of the patients suffered from a very extensive fistula of the anus and had had 2 operations under spinal anesthesia in the hospital prior to the third one which was done under prolonged anesthesia, and which cured the condition. The patient requiring 4 operations had the first one in the hospital for fistula of the anus, which failed to heal, apparently because of the presence of enlarged papillæ. General anesthesia was used.

Secondary operations were made necessary for the following reasons: in 1 case, recurrent fissure; in 2 cases, insufficient skin excisions; in 1 case, an infected crypt; in 1, a retained non-absorbable ligature knot; in 2, unhealed wounds without apparent cause; and in 9, enlarged papillæ, which had been overlooked at the time of the primary operations.

In the 21 cases in which 2 and 3 procedures were required, the intervals between operations varied from 1 to 8 months. The average time elapsed was approximately 2 months. The patient who required 4 operations was given intervals of 6 months, 2½ years, and 3 weeks, respectively.

These facts are of sufficient magnitude to emphasize the necessity of great care in removing any enlarged anal papilla and in preventing pooling of the oil. Any ligature material of the non-absorbable variety should be cut long so that a small knot will not be retained to prevent proper healing. Sufficient skin should be removed to prevent premature healing of the skin over the deeper portion of the wound and to permit adequate, prolonged drainage.

NUMBER OF DRESSINGS REQUIRED FOR EACH PATIENT

Taking into consideration all of the 160 operations performed under prolonged anesthesia, an average of 8.58 dressings was required for each patient. In this group we considered only the number of dressings after the final operations in the re-operated upon group. Of these cases, 88 fissures required an average of 8.3 dressings; 25 fistulas averaged 8.76 dressings; 20 patients in the re-operated upon group showed an average of 9.14 dressings following each of the final operations; the 14 cases of cryptitis and papillitis averaged 7 dressings; the 8 hemorrhoid excisions, 7.6 dressings; in the miscellaneous cases, in which two severe peri-anal abscesses occurred, an average of 10.4 dressings were required for each patient.

HEALING TIME

In 157 patients in this group, in which the healed dates are recorded, an average of 44 days was required for healing. In 157, or 97.5 per cent, of the 161 patients known to be healed, the date on which healing was known to have been complete is accurately recorded. In 85 fissures the wounds were known to be healed on an average of the forty-fourth postoperative day. Twenty-five fistulas required an average of 46 days to heal. In 20 of the re-operated upon patients, and in 14 who were operated upon for cryptitis and papillitis, the average healing time was 41 days. The patients operated upon for internal hemorrhoids required 38.6 days to heal, and the miscellaneous group containing two severe peri-anal infections, required 56 days to heal.

FOLLOW-UP

Of a total of 181 patients operated upon under prolonged anesthesia, 161 or 88.9 per cent, were known to be healed when last seen. The remaining 20, or 11.1 per cent, were lost to follow-up before they were healed. The follow-up results presented herein are based upon personal observations in 155, or 96.2 per cent, of the 161 known healed patients. The 6 remaining healed patients, 3.8 per cent, replied by letter to persistent follow-up inquiries. Of the 161 patients known to be healed, 136, or 84.5 per cent, were followed for more than 3 months; 115, or 71.4 per cent, were followed for more than 6 months; 68 patients, or 42.2 per cent, were under observation for more than 1 year; 14, or 8.7 per cent, were followed for more than 2 years.

SYMPTOM FREE

We shall consider 6 months as a satisfactory follow-up period in these cases. Of the 115 patients followed for more than 6 months, 100, or 86.95 per cent, were symptom free at the end of 6 months following their operations. Of these 115

patients, 6 presented persistent pruritus ani, which was the principal pre-operative complaint. Seven of these 115 patients continued to have occasional bleeding from internal hemorrhoids. One of these was sent into the hospital subsequently for hemorrhoidectomy. The 6 other patients received injections for the hemorrhoids. One patient complained of chafing, and another of some anal pain, the causes for which were not apparent.

CONCLUSIONS

1. It is safe to operate upon selected ambulatory patients under prolonged anesthesia administered in oil for chronic anorectal disease.

2. Great caution must be exercised in the use of this type of anesthetic, because of the potential danger of infection and peri-anal necrosis. Much experience is required for its proper management.

3. Anesthetics injected in oil are slowly absorbed and produce prolonged, effective anesthesia for 2 to 3 weeks or more.

4. This prolonged anesthesia not only greatly reduces the postoperative pain and tenderness but permits the patient to be ambulatory and often to return to work earlier than would be possible under other types of anesthesia.

5. In 194 operations the anesthetic was administered in oil on 181 patients.

6. An average number of 8.58 dressings were required per case in the entire series.

7. A healing time of 44 days per patient was recorded in the healed cases.

8. One hundred and sixty-one, or 88.9 per cent, of these patients were known to be healed, while the remaining 20, or 11.1 per cent, were lost to follow-up before they were recorded as healed. These results are based on personal observation in 155, or 96.2 per cent, of the healed patients. The 6 others replied by letter.

9. One hundred and fifteen, or 71.4 per cent, of the 161 healed patients were followed for more than 6 months which is considered to be a fair follow-up period in these cases. One hundred, or 86.95 per cent, of these 115 patients were symptom free after 6 months.

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EDITORIALS

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THE MODERN TREATMENT OF BURNS

PERHAPS not in this century has one surgeon accomplished so much in the saving of life, the lessening of suffering, and the saving of patients' time and money, as has E. C. Davidson by his work first published in 1925. Since that time there has been an enormous amount of work done on the subject and many chemicals have been used in the treatment of burn wounds. It is questionable, however, whether any of these offer any improvement over the tannic acid treatment if this is carried out properly. Those of us who worked with Davidson for two years before the method was described in the literature and have since tried the different methods suggested, find merit in some of them but not enough, we believe, to affect the death rate materially. The most significant result, however, of Davidson's work is the tremendous renewal in the interest in the subject of burns. To avoid any controversy over the chemical to be used the French have appropriately introduced the term "tanning method of treatment."

Davidson pointed out in his original contribution the equal importance of the prevention, or treatment, of shock and the need of absolute asepsis. We still feel that the tannic acid treatment is most satisfactory if surgical principles are observed. Aseptic methods are always of much more importance than are antiseptic solutions. Two great principles should be observed in the treatment of burns. These principles are fundamental in all types of wounds. They are the treatment of shock and the practice of asepsis. Therefore, if the physician or surgeon would simply regard a burn as a surgical wound to be kept surgically clean, much of the problem would be solved.

Some of the difficulty perhaps lies in the fact that except in larger centers the individual practitioner rarely has the opportunity of observing and treating severe cases. Last year in the United States there were approximately 7,000 deaths resulting from burns. If these cases were equally distributed among the 130,000 practicing doctors each would see only one fatal case in each 18 years of practice. For this reason it is difficult for the physician to bear in mind the details of treatment and natural for him to place his faith in applications to the burned area rather than in the adjunct treatment so essential for a success.

The injury produced by burns whether by flame, hot water, or electricity is very prone to result in shock. No satisfactory response to any type of treatment therefore can be expected until the condition of shock is either prevented or relieved. Pain and restlessness should be alleviated by the administration of

sedatives and heat supplied by the use of warm blankets and hot water bottles, or by placing the patient in a tent or room kept at 90 degrees F. A lowered blood pressure must be treated by the administration of stimulants and fluids given intravenously. Of equal importance in preventing shock is the gentle handling of the patient in quiet and peaceful surroundings. The cleansing of the wound should be done with the greatest of care and without trauma. The insensible loss of body fluids as determined by blood concentration tests must be relieved promptly by the administration of fluids. The best way to do this is by the intravenous administration of blood plasma. This, of course, must be typed as for a blood transfusion. In addition to this, sufficient intravenous infusion of normal or hypertonic salt solution must be given to maintain the blood chlorides at a normal level.

The aseptic treatment of burns was long completely disregarded especially during the period of the use of carron oil. Burn wounds must be treated as carefully as other surgical wounds to avoid infection, and good results cannot be expected simply from the tanning alone. The surrounding unburned skin must be kept scrupulously clean being frequently washed with an antiseptic solution, 70 per cent alcohol being a satisfactory one. Sterile bed linen must be used if infection is to be avoided. No attempt to dissolve the coagulum or to loosen it by the application of wet dressings should be made. This is well illustrated in Davidson's original paper: a convalescing patient so treated was thrown into a condition of marked toxemia within a few hours.

The question of whether or not there ever is actually a toxemia of burns remains unanswered. There is considerable evidence that it does occur even though the toxic substance itself has not yet been isolated. The important thing, however, is a rational treatment of the patient which includes the prevention or treatment of shock, the prevention of infection and the production of an aseptic protective coagulum. The latter in its turn prevents fluid loss and is an aid in preventing infection and we believe may be of some value in the prevention of dissemination throughout the body of toxic substances.

This modern treatment of burns accurately followed has resulted in a noteworthy saving of life, in markedly lessening deformities, in decreasing hospitalization, and in abolishing expensive dressings. ROY D. MCCLURE.

IN recent years there has been a more general recognition of the requirements for the proper care of burns. Linked with this changing attitude there is an increasing appreciation of the nature of the profound systemic changes which so often complicate these injuries.

Because they represent the commonest variety of burns, those produced by heat of a degree incompatible with proper functioning of the tissues have been most intensively studied. The symptoms following the infliction of a severe burn may be divided into three groups: the period of initial shock; the period of secondary or so called toxic burn shock; and the period of repair, which may or may not be complicated by infection. The cause of the constitutional symptoms immediately following burns has long been a matter for speculation and research, both clinical and laboratory. The term "shock" has been loosely applied in clinical medicine, and failure to define accurately conditions under discussion has given rise to confusion in the study of the clinical pathology of burns. Primary shock is neurogenic in character, and is associated with vasodilatation and a decrease in blood pressure, and a consequent reduction in cardiac

output. While this syndrome should always be looked for, it is usually found only in widespread burns affecting numerous nerve endings in the skin. It is concerning the so called secondary toxic burn shock that much controversy exists. The controversy concerns both the mechanism of its production and the time factor involved. Two schools of thought predominate regarding the fundamental character of this reaction. One maintains that at the site of the burn a toxic substance is elaborated by the action of heat on proteins. It is presumed that the absorption of this toxin gives rise to the symptoms grouped under the term "toxic burn shock." Other workers maintain that it is unnecessary to postulate the existence of a specific burn toxin, and substitute the theory that the symptoms can be explained by the shifting of fluids in the body.

In 1898 Bardeen reviewed the various theories on this subject. His conclusions, based on observed changes in the entire lymphatic systems of five children who died several hours after being burned, were a substantiation of the theory that death at this stage is due to toxemia. Blalock and others have done important work which does not confirm the presence of a toxin such as earlier experimental results seemed to prove. Wilson has come to the conclusion that evidence for a specific burn toxin is inconclusive although much of it is suggestive. He maintains that proof of the toxin theory requires the demonstration and identification of the toxic substances not only in the burned area, but also in the circulating blood. Working with others he demonstrated in experimental animals the development of toxicity in the edema fluid which accumulates in a burned area, this property being gradually acquired over a period of 48 hours. Controversy exists as to the possibility of absorption of toxic material from a burned area. Underhill maintains that following a burn the permeability of the capillaries is in one direction only, namely, from the capillaries to the tissues. Recently Mason has demonstrated the absorption of potassium iodide from burned areas, the excretion of this substance being the same as in normal animals.

The confusion regarding the use of the term "toxic burn shock" is exemplified by the existing opinions concerning the time of onset of this syndrome. One author states that it occurs 1 hour after the infliction of a severe burn; another, that it may occur from 6 to 50 hours afterward, and a third states that all shock seen during the first 24 hours is primary in character. Harkins' experimental demonstration that in a burned extremity half of the fluid lost from the blood vessels to the tissues is lost within the first hour is of importance in considering the time of onset of secondary shock. Some evidence has been advanced which tends to show that infection plays a rôle in the production of this early toxemia. Infection is probably not an important factor earlier than the second day in many cases. The early theories which attributed the reaction to burns as due to interference with the functions of the skin have been generally discarded, although it is becoming apparent that our knowledge of the physiology of the skin is far from complete.

In 1925 Davidson suggested the possibility of limiting the absorption of toxic material from burned surfaces by coagulation or precipitation of injured proteins. His studies of the efficiency of various agents led to the development of the tannic acid method of treating the local wound. Because tannic acid possesses the property of precipitating protein, Davidson assumed that through its use fixation of the burned tissues could be accomplished and the absorption of toxic material prevented. The effect of tannic acid is to produce a firm, smooth, mahogany

colored membrane which acts as a protective coating against chemical, bacterial, and mechanical action, as well as against sensory irritation from other sources. One striking effect of the use of tannic acid is the relief of pain, which occurs promptly and often makes further use of sedatives unnecessary. Various modifications of this treatment have been proposed.

The tanning process is a complicated one, and the importance of using solutions of a normal hydrogen-ion concentration has been well demonstrated. The acid solutions usually used produce a very rapid fixation of tannin on the surface and have a tendency to augment the edema of the underlying tissues. McClure recently demonstrated that evaporation from the burned surface has a negligible effect in producing dehydration after a burn. For this reason the early arguments advanced for the use of tannic acid, on the basis that it prevents water loss from the surface, cannot be given much weight. Regardless of its ultimate place in the therapy of burns, Davidson's contribution served to stimulate a revival of interest in this subject. At the present time it is not possible to demonstrate by the statistical method the effect which the tannic acid method of treatment has had upon mortality. It is probable that a more general appreciation of the nature of the systemic changes has had as much to do with any apparent decrease in the death rate as has any single method of treating the local wound. The routine use of blood transfusion and the addition of fluids and chlorides to the depleted vascular supply have been important factors in reducing the mortality rate during the first few days. In some reported series more patients survived than formerly the periods of initial and secondary shock only to die at a later stage of exhaustion, sepsis, or pneumonia.

The fact that the mortality rate in the early stages may be lowered means that more patients will reach the stage of the large granulating wound. The treatment of these wounds offers a challenge which is worthy of any surgeon. These patients present the problems of maintenance of body nutrition, the control of infection, the preparation of the granulating surface for the reception of skin grafts, the grafting of skin, and the prevention of contractures and ankylosis. Mastery of the techniques involved in the accomplishment of these various objectives is far from being universal. The application of pressure dressings for the control of exuberant granulations is an old method which has assumed only within recent years a place consistent with its value.

Large granulating wounds should be covered with epithelium at the earliest possible moment. The derma, or true skin, is derived from the mesoderm and is, therefore, a tissue which is not designed to serve as a source of epithelial development. While small areas of the stratum germinativum of the epidermis may remain viable in extensive burns, and at times undestroyed hair follicles may act as centers for the growth of epithelium, one should not delay too long in the hope that epithelization will be brought about in this manner. Ingrowth from the margins of the wound is to be relied on only in burns of small area. Delay in epithelization means an increase in scar tissue and greater deformity.

The protracted suffering of the unfortunate victims of these tragedies, and the resulting disfigurement and loss of morale present important economic as well as surgical and medical considerations. In the past the management as well as the care of these patients has been relegated too often to the youngest house officer. It is encouraging to note that within recent years leaders of surgical thought have given these problems a degree of consideration more nearly consistent with their importance.

STANLEY J. SEEGER.

MEMOIR

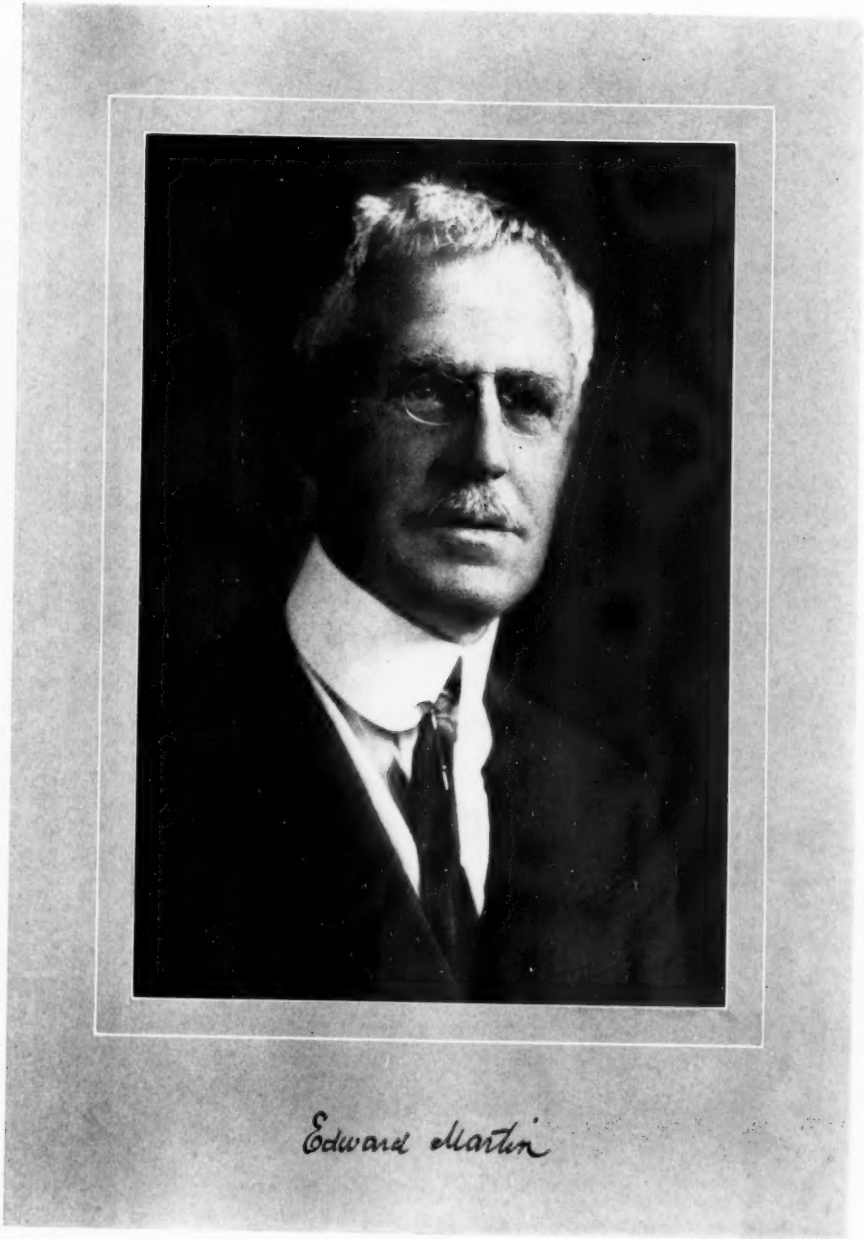
EDWARD MARTIN

EDWARD MARTIN, the youngest son of Jonathan Willis and Malvina Regester Martin, was born in Philadelphia on August 14, 1859. His preliminary education was obtained in the public schools of this city and for a short period at Central High School. He attended Swarthmore College four years, ranking first or second in all classes and obtaining Phi Beta Kappa. He graduated in 1878, *magna cum laude*, obtaining the degree of A.B. at that time and later (1882) A.M., and (1920) D.Sc. from this College. He graduated from the medical school of the University of Pennsylvania in 1883 and served as assistant to Dr. D. Hayes Agnew and later to Dr. J. Wm. White. For a few years he practiced medicine and then devoted his time to the lines in which he ultimately specialized—genito-urinary and general surgery. He was a prolific writer, being the author of several authoritative textbooks on surgical subjects, sections for medical systems, editor of the University medical magazine and surgical editor of *The Therapeutic Gazette*, and as well he wrote innumerable papers which were read before various medical societies. He was a true teacher, with the ability so to present his thoughts as to impress them indelibly upon his listeners.

His loyalty and affection to Swarthmore College and the University of Pennsylvania were outstanding—nothing that he could do would ever be enough, in his estimation, to repay these two institutions for what they had done for him. He worked indefatigably for them in every way that he could. His motto was "The best is yet to come" and with this in view he worked and planned to the last for work in the Edward Martin Biological Laboratory at Swarthmore, which laboratory was really a tribute to the lasting friendship existing between Mr. Fred M. Kirby and Dr. Martin, and made possible by Mr. Kirby's generous million dollar gift for this purpose.

Another permanent memorial to this friendship was the Kirby Fund, founded by Mr. Kirby for the benefit of students who needed financial aid to complete their medical course. It was instituted after Mr. Kirby heard Dr. Martin tell of a student who tried to work his way through medical college and died in the effort. Under this fund students were enabled to borrow such money as they required, paying it back to the Fund as soon as they became able to do so. Dr. Martin helped financially and through his influence obtained scholarships for more than one young man—and these men have since achieved success in the medical and other professions, thanks to his effort and encouragement.

Dr. Martin was a pioneer in many lines—prior to the Wright Brothers' achievements, he and Dr. Paul Chamberlin conducted a number of experiments to prove



Edward Martin

air flight possible. He also was interested in the Eastman Kodak films from a teaching standpoint and made several trips to the Eastman plant in the making of motion picture films—one of which dealt with appendicitis—to be used in the medical schools. He was a pioneer in the use of the lantern slide and later movie films for student teaching.

He was the first man in the University of Pennsylvania Hospital to use morphia after an abdominal operation and to Dr. Martin we owe the deep breathing exercises to prevent postoperative pulmonary complications, which practice has withstood the test of time and is today used even more commonly than is carbon dioxide. He early practiced the no touch or instrument technique in surgery using white cotton gloves as tell tales on the offender. Gentleness in the handling of tissue was his daily admonition.

In all things Dr. Martin believed in preparedness, and this, with his ideas on loyalty, honesty of purpose, kindliness, tactfulness and consideration in the handling of his patients, constituted his creed. He was honest with himself and others in all his dealings, a strict disciplinarian himself yet most charitable of the failings of others.

Dr. Martin had many allied activities in public enterprises. It was through his efforts that typhoid fever was stamped out during the Spanish American War; he was director of health and charities in Philadelphia under Mayor Weaver from 1903 to 1905; commissioner of health in Pennsylvania from 1918 to 1923 under Governor William Sproul (a classmate of his at Swarthmore); he inaugurated the traveling dental and prenatal clinics, did special work regarding syphilis and gonorrhea, instituted the use of toxin antitoxin for preschool age children and of antitoxin early in diphtheria, was responsible for schools of instruction held 1 week each summer for state inspectors. The Philadelphia Health Council and their good work against tuberculosis is the result of his efforts.

Since 1885 he was a member of the board of managers of Swarthmore College, a member of the board of education since 1911 and president at the time of his death. He was elected clinical professor of surgery of the Women's Medical College of Pennsylvania in 1902, resigning after several years. He was professor of clinical surgery at the University of Pennsylvania, 1903–1910, and John Rhea Barton professor of surgery at the same institution from 1910 to 1918. He also served the University of Pennsylvania as professor of surgical physiology. He was chief surgeon to the University of Pennsylvania and the Howard Hospitals, consulting surgeon to Bryn Mawr Hospital, Norristown State Hospital for the Insane, State Hospital for the Insane at Wernersville and the Philadelphia General Hospital.

He was a Fellow and Regent of the American College of Surgeons and the second president of the Clinical Congress of Surgeons of North America, a member of the American Philosophical Society, American Surgical Association, Society of

Clinical Surgery, American Association of Genito-Urinary Surgeons, and of several foreign surgical societies, as well as the local state and county organizations. Incidentally, he was a member of the Philadelphia County Medical Society for 54 years and received a framed certificate to that effect which he prized very highly. In 1935 Temple University conferred on him the degree of Sc.D.

Dr. Martin's war record covered a period of many years, he having been a Reserve Officer for some years and in the O. R. C. several years before the World War. His active service in the World War began in Philadelphia on January 1, 1918, although he had been a member of the Medical Section, Council of National Defense from the beginning of the war. Dr. Martin was lieutenant, major, lieutenant colonel, colonel, reserve officer of the World War—364th Medical Regiment, O. R. C., U. S. A.; regimental and brigade surgeon, Spanish American War; surgeon and major in Third Regiment National Guard of Pennsylvania for twelve years in the early '90s; director of School of Surgery, Fort Oglethorpe, Georgia, also chief of surgical section of hospital. He was the first director of Base Hospital No. 20 of the University of Pennsylvania; however, he was soon called back to Washington, being succeeded by his assistant, Dr. J. B. Carnett who carried it to its fruition. Dr. Martin was chairman of states committee—School of Surgery, University of Pennsylvania, for medical officers of the Army; director of professional service and surgical chief Walter Reed Hospital; chairman of states committee, Advisory Board, Medical Section, Council of National Defense. He was honorably discharged from the service on January 27, 1919.

Athletics always aroused his greatest enthusiasm. He was on a winning crew of the University of Pennsylvania in the '80s, played tennis, fished, and in later years was an ardent golfer. At the close of the football season he acted as host to the entire football squad of Swarthmore College, giving a traditional dinner at The Lamb's Tavern with the main feature on the menu a suckling pig with a red apple in its mouth!

For a number of years beginning in 1903, Dr. and Mrs. Martin entertained children from the city slums at Valley Farm, a short distance from their Orchard Farm. These youngsters were exceptionally well cared for during their stay and were returned to their home after a vacation of a week or two; Girl Scouts have occupied a part of Dr. Martin's farm for several years, his cousin presiding as hostess. For the past 20 years Dr. Martin spent his winters in Florida, his summers at Orchard Farm, Media, Pennsylvania, and about a month at his home in Graefenburg Springs in the beautiful South Mountain part of the Blue Ridge chain. There were many deer here and he planned to give this estate to the State as a game preserve after the death of Mrs. Martin and himself.

He was a member of the Jury, Rittenhouse, Pine Valley Golf, Rolling Green Golf, and Seaview Golf Clubs.

Endowed with a keen, quick sense of humor, Dr. Martin with his 6 foot 1 inch straight soldierly carriage and dark auburn hair, was much in demand among his friends and professional colleagues, excelling alike as speaker, toastmaster or host —he was never at a loss for the appropriate word or expression in any situation. He was extraordinarily clever as a correspondent and always kindly, sympathetic, and helpful to those who were fortunate enough to come in contact with him. He was quick to sense any possible talent in those in whom he was interested and would do all in his power to bring such talent to perfection. The death of his wife last fall after many years of companionship was a great loss to him.

And so lived a great man—a true servant of the public—whose virtues often escaped the superficial observer as is true of so many of the world's kindest and most helpful members whose sincerity and naturalness leads them to hide their real selves behind a "smoke screen" to escape embarrassing acclaim. Of no one was this more true than of that Hicksite Quaker—Edward Martin.

E. L. Eliason.

LANDMARKS IN SURGERY

SURGEON JAMES MANN, U. S. ARMY; OBSERVATIONS ON BATTLEFIELD AMPUTATIONS

JAMES M. PHALEN, M.D., Washington, District of Columbia

JAMES MANN was born in Wrentham, Norfolk County, Massachusetts, on July 3, 1759. Graduating with an arts degree from Harvard College in 1776, he studied medicine with Dr. Samuel Danforth of Boston and on July 1, 1779, was appointed surgeon of Colonel William Shepard's 4th Massachusetts Regiment in the Continental army. After the war he practiced medicine and surgery in Wrentham. At the time of Shays' Rebellion in western Massachusetts he was called to duty with the state militia. With the outbreak of the war with Britain in 1812 he was commissioned a surgeon in the regular forces and appointed medical director of the Northern Army under General Henry Dearborn. Until the appointment of James Tilton as Surgeon General in June, 1813, Surgeon Mann was the senior medical officer in the service and remained in charge of the medical service in the field until the close of the war. Thereafter he served practically until his death in 1832 at Fort Independence in Boston Harbor. In 1819 he was appointed to the surgical staff of the Massachusetts General Hospital in succession to his old preceptor, Dr. Danforth. He became an influential and useful member of the state medical society. In 1822 he reported in the *Medical Repository* of New York a successful amputation at the elbow joint performed the previous year with favorable claims for joint amputations.

Following the close of the war Surgeon Mann prepared and published his *Medical Sketches of the Campaigns of 1812, 13, 14* (Dedham 1816), which constitutes the principal source of information in regard to the medical history of the War of 1812. It covers the operations of the Northern Army in considerable detail with observations upon the topography of the area of combat. Much of the medical section is devoted to the discussion of dysentery, pneumonia and the illy identified fevers which plagued the army. It is of interest to note that he advocated the use of ipecac in the treatment of dysentery.

The section devoted to surgery is mainly given over to the pronouncements of Baron Larrey in his *Mémoires de Chirurgie Militaire* (Paris, 1812) on the indications for primary and secondary amputations in battle casualties, and their evaluation in the light of his experience in the late war. Though in the main in agreement with Larrey's dicta and citing case reports in their support, he dissents sharply from certain of the great Frenchman's arbitrary rules and finds many exceptions in his indications for mandatory amputation.

Taking up Larrey's axioms serially he agrees that "when a limb is carried away by a ball, by the bursting of a grenade or a bomb, the most prompt amputation is necessary." He agrees also that "when a body is projected from a cannon and strikes a limb so that the bones are fractured and the soft parts violently contused, extensively torn, and broken up, amputation should be instantly performed." Larrey's third proposition that "when a large portion of the soft parts and the principal vessels of a limb are carried away by a ball and the bone fractured, amputation should be immediately performed," also meets with his approval.

The capture of Little York (Toronto) by General Dearborn's army in April, 1813, was attended by the explosion of the enemy's powder magazine which produced scores of frightfully mutilating wounds among the American forces. Conditions for treatment of these casualties were highly unfavorable and Mann tells of the disastrous results of amputations too long delayed. On the other hand, he speaks of fortunate results attending early amputation in cases of similar character.

Larrey's fourth rule says that "when a large ball strikes a thick part of a limb, breaks the bone, cuts and tears the muscles, destroys the great nerves and yet leaves the principal artery entire, immediate amputation should be resorted to." Mann dissents from unqualified acceptance of this rule and cites 3 cases in which not only life but fairly useful limbs were saved.

The fifth rule pertains to the effects of a spent missile which, without breaking the skin, produces more or less damage to the underlying tissues. Bones may be broken, muscles shattered, and blood vessels cut off. Mann agrees with Larrey's dictum that the necessity for amputation must depend upon a determination of the site and nature of the deep traumatism. It was agreed that an incision was indicated for this purpose and for drainage of any hematoma.

Larrey's sixth indication relates to the injury caused by a missile which "has fractured the orbicular extremities, more particularly those which form the knee, or the ankle joint and when the ligaments which surround these articulations have been torn or broken up." Mann dissents strongly from the necessity for amputation in these cases and states that numerous instances of musket ball wounds of joints

were successfully treated without amputation and that in any case there was every reason to attempt the salvage of the limb.

The seventh rule calls for amputation when a missile passing through a limb "denudes a large portion of the bone without fracturing it." After stating this condition as an indication it was advised that symptoms should be attentively considered before a decision for amputation is made. Mann says that cases of this character rarely require amputation and that always they should be "consecutive" (secondary) operations.

Larrey's eighth indication for primary amputation is a large opening by a cutting weapon into the larger joints, such as the knee or elbow. He gives as his reason the great liability to fatal infections. Mann considers that expectant treatment is warranted in these cases and cites instances of good recovery from such joint wounds.

In the axioms of Larrey the use of the terms "most prompt," "instantly," "immediately," and "without delay," in relation to battlefield amputations attracts attention. Without criticizing this feature of the great surgeon's dicta, Mann makes the observation, well confirmed by later experience, that a greater mortality followed early amputations than those which were deferred. His whole experience pointed to a conservative attitude in relation to indications for amputation and he was struck with the highly fatal results of such operations performed in haste under unfavorable conditions of weather and shelter. In his discussion of Larrey's indications for "consecutive" amputations, he appears to be in more agreement with that great authority.

Traumatic gangrene, it was agreed, demanded early amputation to forestall absorption of the "deleterious principle." "Convulsive spasm of a wounded limb" is accepted as an absolute indication for its amputation, though Mann states that he encountered no case of tetanus during the war. An ununited compound fracture with continuing purulent discharge was a problem to be solved only by amputation. Mann reports excellent results in gunshot fractures of the femur from the use of the Desault splint, constructed for extension and counter-extension of the limb, and praised the modification devised by Dr. Philip Physick of Philadelphia.

"Bad state of the stump" is a general term for various conditions demanding reamputation. Mann agrees with Larrey that every means of treatment should be exhausted before reamputation is made.

It should be understood that while Mann was the medical advisor of the army commander he was also at all times in charge of a general hospital at army headquarters and always its chief operating surgeon. He thus had first-hand practical knowledge of the subject of which he writes. He was a contemporary of Baron Larrey, whose war experience and writing antedated Mann's by but a few years. While mainly deferring to Larrey's great authority, his attitude on indications for amputation was decidedly more conservative. In following this conservative bent he arrived by experience at the important conclusions that some delay was advantageous in a majority of cases, that by deferring amputation the operation was often found unnecessary and that amputations so deferred were attended by a lesser mortality.

Had these significant lessons been planted firmly in the mind of every medical officer it would not have been necessary to learn them anew, by bitter experience, in every succeeding war for the remainder of the century.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN THE field of diseases of the lung one of the striking developments during the past two decades has been the marked increase in the incidence of carcinoma of the bronchus. From being a rare disease it has come to be exceedingly common and has, accordingly, attracted a great deal of attention and been the subject of a great number of articles. Numerous points of discussion have arisen concerning the increase in incidence, the pathology, and the treatment. *Primary Carcinoma of the Lung*[1] by Simons is a careful review of a very extensive literature and for that reason is exceedingly valuable. This is not the first book on this subject but is the most recent and most complete. For any one working in this field who has not had time to read everything written it should provide a satisfactory shortcut. JEROME R. HEAD.

IN THIS present day of growing interest and understanding concerning the autonomic nervous system, it requires no small amount of courage to undertake the task which Gask and Ross have so well handled in this, the second edition of their successful work first published in 1933, *The Surgery of the Sympathetic Nervous System*.[2] The authors forewarn the reader that they do not intend to compile a complete record of all the conditions which are today being treated by sympathectomy, and their discussion covers only surgery of the thoracolumbar portion of the autonomic nervous system. They have deliberately omitted any treatment of the subjects of retinitis pigmentosa, hyperhidrosis, hypertension, and bronchial asthma.

The section dealing with circulatory disease, and particularly with Raynaud's disease, is an especially enlightening one, and the authors apparently have had a wide experience in the surgical treatment of these conditions. They stress the importance of an exhaustive pre-operative study to select cases suitable for surgery, and they look with definite favor on such treatment, but here, as elsewhere in their book, they are conservative and restrained from overinterpretation of their experiences and from overenthusiasm for their own results. They take a very definite stand in favor of the periarterial neurectomy operation of Leriche, properly applied.

The plan of the book is pleasingly simple and direct, and it is based entirely on a careful study of the authors' own cases. The section on the anatomy and physiology of the sympathetic nervous system is clear, concise, and free of theorizing, ambiguous statements, yet accuracy is not at all sacrificed. There are sections on (a) sympathectomy for disorders of the circulation, (b) sympathectomy for disorders of the visceral motor mechanism (gastrointestinal and urinary tracts), and (c) sympathectomy for pain, that is, visceral pain and causalgia. The illustrations, while not profuse, are adequate. JOHN MARTIN.

THIS monograph[3] by MacKee and Cipollaro was prepared with the idea of reducing the mortality from accessible cancer. It was written not only for general practitioners but for all physicians interested in the cancer problem.

This type of monograph was badly needed and the publishers are to be congratulated not only for seeing the need of such a work but for their choice of authors. No one is better able to write such a book than MacKee with his long years of clinical experience in dermatology and radiotherapy.

The work is divided into four chapters: (1) a few pages dealing with the morbidity and mortality of cutaneous cancer; (2) the precancerous dermatoses. Twenty different dermatoses of precancerous character are briefly but fully described in this chapter; (3) carcinoma and sarcoma; (4) established therapeutic methods.

The monograph is not long. There are only 222 pages of reading matter but in this short volume is packed a fund of valuable information. Each subject is handled in such a clear, concise manner that it is an extremely easy book to read. As the aim of the work is entirely practical, many questions and theoretical matters are omitted. On the subject of treatment, the authors have not attempted to describe in minute detail therapeutic measures but have simply indicated the recommended form of treatment.

There are 231 splendid illustrations—photographs of cutaneous lesions and photomicrographs.

There is an extensive bibliography at the end of each chapter. The book is printed on good paper in clear, legible type.

The authors have attempted to present the symptomatology, diagnosis, etiology, pathology, and treatment of precancer and cancer of the skin and mucosa as concisely and clearly as possible. In that they have succeeded admirably. This book should be added to the library of every practicing physician. It is a splendid work. E. A. OLIVER.

[1] PRIMARY CARCINOMA OF THE LUNG. By Edwin J. Simons, M.D. Chicago: The Year Book Publishers, Inc., 1937.

[2] THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By George E. Gask, C.M.G., D.S.O., F.R.C.S.(Eng.) and J. Paterson Ross, M.S. (Lond.), F.R.C.S.(Eng.). 2d ed. Baltimore: William Wood & Co., 1937.

[3] CUTANEOUS CANCER AND PRECANCER; A PRACTICAL MONOGRAPH. By George M. MacKee, M.D., and Anthony C. Cipollaro, M.D. New York: The American Journal of Cancer, 1937.

THE term "disruptive chemiotaxis" has been coined by Bertwistle in his recent book[1] to express the power of certain hard substances (bone) of attracting and drawing into themselves certain soft, living structures. An example would be the attraction of the earth and its moisture for roots as seen in the study of the germinating seed.

The chapters dealing with the histology and development of bone contain the standard text on bone growth and are concise and clear. The author then lays down the following law: Whenever young fibrous tissue, particularly young blood vessels, is in contact with bone or a calcium deposit, bone will form. The question of periosteal bone generation is discussed. Evidence of each school of thought is presented. The author believes that the periosteum is capable of producing bone according to the law stated. This is illustrated by the fracture in which we have hemorrhage about the bone ends, the cells in the vicinity die leaving a calcified deposit which is invaded by fibrous tissue cells, becoming bone cells. The problem of ectopic bone formation is presented. Original evidence is lacking to either confirm or negate the proposed theories except that disruptive chemiotaxis may account for the invasion of calcified material by young blood vessels. The object of the book is to present this viewpoint.

LEON J. ARIES.

IT SHOULD be respectfully noted that with the withdrawal of Sir Robert Muir from active participation, the original authorship of the book, *Muir and Ritchie's Manual of Bacteriology*,[2] which was first published in 1897, has come to an end. Detailed review of this well known standard English text is quite unnecessary. Suffice to state that the present writers, alert to the recent advances in the subject, have brought the book up to date and maintain the spirit and high character of the previous editions. However, it is again remarked that the small type employed and the narrow inner page margin, together with the tight binding, interfere with ease of perusal.

A. A. DAY.

FREIBURG is one of the centers of research in endocrinology. The relatively brief monograph, *Innere Sekretion und Chirurgie*,[3] from the Surgical Department there reviews the physiology of the glands of internal secretion, outlines very briefly the diseases of these glands, and mentions the surgical indications for their hormones. The section on each gland is followed by a bibliography of considerable extent. The discussion of such subjects as the preoperative iodine remission of hyperthyroidism, or the postoperative management of parathyroid tetany is inadequate. Nevertheless, the book furnishes a starting point and represents much German work and practice in this field.

PAUL STARR.

ALTHOUGH the first edition of Hamilton Bailey's *Physical Signs in Clinical Surgery*[4] was published in 1927, we in America have failed to recognize the full import of this splendid book. The present volume, the sixth of its kind, is even more valuable. Short, containing but 284 pages, it reads like a story book. Within these pages are contained 334 photographs, many in color. These colored plates are perhaps the most beautiful it has been my pleasure to find in any medical work.

The story behind Bailey's book can best be given in the author's own words, taken from the preface to previous editions, in which he states:

> There is a growing tendency to rely on laboratory and other auxiliary reports for a diagnosis. . . . A former chief was wont to picture the modern graduate of medicine, when summoned to an urgent call, driving up to the patient's house followed by a pantechnicon containing a fully equipped X-ray installation, and a laboratory with a staff of assistants. Without these aids the future doctor would be unable to formulate a diagnosis. . . . The history, and physical methods of examination, must always remain the main channels by which a diagnosis is made.

The medical man has put much stress and is very proud of his ability to interpret physical signs, but, unfortunately, the surgeon has been, only too often, considered a mechanic. This book will do much to dispel this idea. It is the elicitation of physical signs in their relationship to clinical surgery which makes this book so valuable. Particular emphasis is placed on the eyes, ears, and hands in arriving at the correct diagnosis. The use of other adjuncts, especially those of the X-ray, chemical, bacteriological, and histological examinations are given their importance, but as confirmatory evidence.

The book is divided into 26 chapters, each dealing with a special section of the body. Each division is critically analyzed, and the more important physical signs, as related to a given disease are presented (mostly by way of pictures). In addition an explanatory note is offered as to why certain signs are obtained.

One of the most valuable chapters is that which deals with the physical signs found in the common acute abdominal conditions. Acute appendicitis, appendiceal abscess, ruptured peptic ulcer, acute cholecystitis, acute intestinal obstruction, intussusception, ectopic gestation, and acute retention of urine are discussed.

Although Bailey's book offers nothing startlingly new as to physical signs, it is the way the author has put this book together which makes it valuable. His use of pictures, and especially the colored photographs, adds much to the interest of the book. Every medical man, be he surgeon or not, will find much of benefit in Bailey's *Physical Signs in Clinical Surgery*.

EARLE I. GREENE.

[1] THE RÔLE OF CHEMIOTAXIS IN BONE GROWTH. By A. P. Bertwistle, M.B., Ch.B., F.R.C.S.(Edin.). London: Henry Kimpton, 1937.

[2] MUIR AND RITCHIE'S MANUAL OF BACTERIOLOGY. Revised by Carl H. Browning, M.D., LL.D., D.P.H., F.R.S., and Thomas J. Mackie, M.D., D.P.H. 10th ed. London: Oxford University Press, 1937.

[3] INNERE SEKRETION UND CHIRURGIE. By Hans Hanke. Berlin: Julius Springer, 1937.

[4] DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY. By Hamilton Bailey, F.R.C.S.(Eng.). 6th rev. ed. Baltimore: William Wood & Co., 1937.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

HOW ANCIENT HEALING GOVERNS MODERN THERAPEUTICS. THE CONTRIBUTION OF HELLENIC SCIENCE TO MODERN MEDICINE AND SCIENTIFIC PROGRESS. By Kleanthes A. Ligeros, M.D., Ph.D. New York and London: G. P. Putnam's Sons, 1937.

CLÍNICA Y TERAPÉUTICA QUIRÚRGICAS DE URGENCIA. By M. Corachán García and F. Doménech-Alsina. Barcelona, Madrid, Buenos Aires, Rio de Janeiro: Editorial Labor, S.A., 1937.

INTRODUCTION TO OPHTHALMOLOGY. By Peter C. Kronfeld, M.D. Springfield, Ill.: Charles C. Thomas, 1938.

A SYMPOSIUM ON CANCER. GIVEN AT AN INSTITUTE ON CANCER CONDUCTED BY THE MEDICAL SCHOOL OF THE UNIVERSITY OF WISCONSIN. Madison: The University of Wisconsin Press, 1938.

CLINICAL ROENTGEN THERAPY. Edited by Ernst A. Pohle, M.D., Ph.D., F.A.C.R. Foreword by George W. Holmes, M.D. Philadelphia: Lea & Febiger, 1938.

TREIZE COUPES HORIZONTALES DE THORAX. By A. Hovelacque, Olivier Monod, Henri Evrard. Drawings by Arnould Moreaux. Paris: Librairie Maloine, 1938.

MEN PAST FORTY. By A. F. Niemoeller, A.B., M.A., B.S. With a foreword by Winfield Scott Pugh, B.S., M.D. New York: Harvest House, 1938.

THE FIGHT FOR LIFE. By Paul de Kruif. New York: Harcourt, Brace & Co., 1938.

A CHALLENGE TO SEX CENSORS. By Theodore Schroeder. New York: 1938.

HEMORRHOIDS. By Marion C. Pruitt, M.D., L.R.C.P., S.(Ed.). St. Louis: The C. V. Mosby Co., 1938.

NEURO-OPHTHALMOLOGY. By R. Lindsay Rea, B.Sc., M.Ch., F.R.C.S. St. Louis: The C. V. Mosby Co., 1938.

THE HEART IN PREGNANCY. By Julius Jensen. St. Louis: The C. V. Mosby Co., 1938.

SYMPTOMS OF VISCERAL DISEASE; A STUDY OF THE VEGETATIVE NERVOUS SYSTEM, etc. By Francis Marion Pottenger, A.M., M.D., LL.D., F.A.C.P. 5th ed. St. Louis: The C. V. Mosby Co., 1938.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Vol. 62, for the Year 1937. Edited by Richard W. TeLinde, M.D. St. Louis: The C. V. Mosby Co., 1938.

O PROBLEMA DA LUXAÇAO CONGENITA DO QUADRIL NO BRASIL. By Dr. Rezende Puech. S. Paulo, Brazil: Empreza Graphica da Revista dos Tribunaes, 1937.

LAS NEUMECTOMIAS TOTALES. By Jorge A. Galarce. Buenos Aires: Editor: "El Ateneo," 1937.

OXFORD MEDICAL PUBLICATIONS. HISTOLOGICAL TECHNIQUE; FOR NORMAL TISSUES, MORBID CHANGES AND THE IDENTIFICATION OF PARASITES. By H. M. Carleton, M.A., B.Sc., D.Phil., and E. H. Leach, M.A., B.Sc. Chapters vi and vii in collaboration with Frederic Haynes, M.A. 2d ed. London, New York, Toronto: Oxford University Press, 1938.

THORACIC SURGERY. A revised and abridged edition of Sauerbruch's Die Chirurgie der Brustorgane. By Ferdinand Sauerbruch and Laurence O'Shaughnessy, F.R.C.S. Baltimore: William Wood & Co., 1937.

NATIONAL MEDICAL MONOGRAPHS. FRACTURES AND DISLOCATIONS. Vols. 1 and 2. By Philip Lewin, B.S., M.D. Edited by Morris Fishbein, M.D. New York: National Medical Book Co., Inc., 1937.

ATHLETIC INJURIES; PREVENTION, DIAGNOSIS AND TREATMENT. By Augustus Thorndike, Jr., M.D. Philadelphia: Lea & Febiger, 1938.

A PRACTICAL GUIDE TO MASSAGE. By C. Irene Carpenter. With introduction by David Katz, Ph.D. Baltimore: William Wood & Co., 1937.

MASSAGE AND REMEDIAL EXERCISES; IN MEDICAL AND SURGICAL CONDITIONS. By Noël M. Tidy. 3d ed. Baltimore: William Wood & Co., 1937.

PEDIATRIC SURGERY. By Edward C. Brenner, A.B., M.D., F.A.C.S. Philadelphia: Lea & Febiger, 1938.

PROGRESSIVE RELAXATION; A PHYSIOLOGICAL AND CLINICAL INVESTIGATION OF MUSCULAR STATES AND THEIR SIGNIFICANCE IN PSYCHOLOGY AND MEDICAL PRACTICE. By Edmund Jacobson, A.M., Ph.D., M.D. 2d ed. Chicago, Ill.: The University of Chicago Press, 1938.

ESSENTIALS OF OBSTETRICAL AND GYNECOLOGICAL PATHOLOGY; WITH CLINICAL CORRELATION. By Marion Douglass, M.D., F.A.C.S., and Robert L. Faulkner, M.D. St. Louis: The C. V. Mosby Co., 1938.

CORRESPONDENCE

AMERICAN CONGRESS ON OBSTETRICS AND GYNECOLOGY

SEVERAL meetings have been held by the members and directors of the American Committee on Maternal Welfare, Inc. to develop the arrangements for convening the Congress in Cleveland, Ohio, during the week of September 11, 1939.

The Congress has been organized to include the interests of medical educators, physicians, nurses, public health workers, hospital administrators, and others interested in the problems of human reproduction.

Morning sessions will be devoted to the presentation of scientific and technical papers. In the afternoons general discussions will be held, and the evening sessions will be open to the public.

All inquiries should be directed to the general chairman of the Congress, Dr. Fred L. Adair, whose executive office is at the Annex of the American College of Surgeons, 650 Rush Street, Chicago, Illinois.

AMERICAN COLLEGE OF SURGEONS

GRADUATE TRAINING FOR SURGERY—GENERAL SURGERY AND THE SURGICAL SPECIALTIES

DALLAS B. PHEMISTER, M.D., F.A.C.S., Chicago, Illinois

FOR 25 years the American College of Surgeons has pursued its objective—to advance the science of surgery and to insure the competent practice of its art. During those years the knowledge on which the science of surgery is based has been greatly broadened and the techniques on which the art of surgery depends have steadily become more intricate and varied. In line with progress, the College has concerned itself with the lengthening and strengthening of preparatory study and training for doctors who aspire to a surgical career, in order to assure the patient of service which is commensurate with the latest and best practice.

The advancement of surgery is dependent upon better trained surgeons. A year's interneship following graduation from medical school does not provide training sufficient to equip the doctor to perform surgery independent of supervision. His knowledge of theory and his observation of procedures should be supplemented by skill and good judgment acquired firsthand but under experienced eyes. Otherwise the life of the patient is endangered.

The American College of Surgeons, as it begins its second quarter century of service, commits itself to a thorough, systematic, and determined effort to advance graduate training for surgery. Only through such an effort can it continue to fulfill its obligation to the profession and to the public—to protect the patient from incompetent surgery. Graduate training is not merely a classroom or laboratory function and should not be confused with postgraduate study which means the pursuit of an already acquired training in a specialty.

It is important, first, to say that the fault does not lie with many recent graduates who must acquire their experience unguided. Not from them will complaint be heard when extension of the training period becomes the rule rather than the exception. They have proved themselves eager for opportunities to gain thorough training, but corresponding eagerness has not been shown heretofore in providing such opportunities for them.

The College is taking into consideration the impressive fact that there were in existence in 1937 only 164 hospitals approved by the American Medical Association for residencies in general surgery; 292 hospitals were approved for residencies in the surgical specialties. These hospitals accommodated 580 residents in general surgery and 910 in the surgical specialties. The figures, of course, do not represent the number of residencies available each year, since some of the appointments are for periods of from 15 months to more than 3 years. It is therefore quite generally conceded that if thoroughly trained surgeons are to be supplied in sufficient numbers, more opportunities for graduate training must be provided. Hospitals which offer residencies are deluged with applications. Failing of acceptance in these, the graduate seizes a lesser opportunity where he can, but he is likely to be among the large group who are faced with the discouraging fact that there are for them no supervised training facilities. Sometimes, like his predecessors of an earlier era, the graduate is fortunate enough to become associated with an older and experienced surgeon who will supervise his work. The training of a surgeon, however, should not be left to chance.

The College began its study of graduate training for surgery in 1930. Four years later a committee was formed under the chairmanship of Dr. Samuel C. Harvey of New Haven, Connecticut, who submitted his report at the annual meeting of the College in San Francisco in October, 1935, recommending that "in conjunction with the development of a program for graduate training for surgery a re-study be made of the requirements for admission to fellowship in the College." Since that time the College has been surveying the possibilities for graduate training, and following the particularly broad investigation conducted by its special field representatives in 1937, the results of which are published in the *Bulletin* for January, 1938, it is ready to state authoritatively that it is

Chairman, Committee on Graduate Training for Surgery, American College of Surgeons.

upon hospitals not controlled by medical schools that effort must be concentrated. Most medical school hospitals are providing excellent training—but naturally they cannot undertake to train all the surgeons who are needed.

To quote from the report of the College survey:

"Residencies in selected hospitals afford the broadest opportunities for training a larger number of surgeons, or rather for the more thorough training of a larger number. Any plan for the extension of residencies into this group of hospitals should take into consideration the fact that graduate training for general surgery and the surgical specialties necessitates a carefully directed and supervised apprenticeship in which the graduate actually participates in practical surgical work. Consideration should also be given to the facilities for further study of the fundamental sciences of anatomy, physiology, and pathology as well as for the acquisition of a detailed knowledge of the past and current literature of surgery. This implies more affiliations with medical schools and more co-operative effort in graduate training programs."

The 1937 report of survey by the American College of Surgeons was based on 140 selected hospitals of all types which present facilities for graduate training in general surgery and the surgical specialties. The purpose was to obtain detailed information regarding the duration and quality of training being given in various hospitals. Valuable data were gathered. It was discovered that "there exists no basic standard of uniformity in the methods of graduate training," to quote the language of the report, which goes on to say: "This lack of uniformity is not sectional or provincial, for even in the same cities, there is this heterogeneity of methods and opinion regarding courses of training." It was also found that "a few of the best planned and best functioning surgical residencies are in non-university connected hospitals" which should be encouraging to the hospital that has hesitated to establish residencies because it is not a so-called "teaching hospital."

As the result of an analysis by Dr. Malcolm T. MacEachern and his associates of information gathered by the College, there were formulated "Criteria for Graduate Training for Surgery" supplemented by a "Manual of Graduate Training for Surgery." The manual is the first concrete help that is being offered to the groups upon whom will fall the responsibility for extending more and better opportunities for graduate training.

The magnitude and importance of any program in graduate training for surgery may be judged from the fact that more than 2,500,000 operations are performed in the United States and Canada annually by some 35,000 doctors, many doing only the limited surgery of their general practice.

The experience of the College in promoting Hospital Standardization has qualified it for leadership in interesting a greater number of approved hospitals to provide acceptable graduate training. Three competent, long experienced officers of the College are engaged this year in carefully noting and recording the respects in which those hospitals having residents are meeting the criteria and the extent of the adjustments others would have to make to establish graduate training facilities that could be approved under this standard. Three hundred and eighty-six hospitals are included in the 1938 survey. The complete, detailed reports are being reviewed by the following Committee on Graduate Training for Surgery, which will determine the hospitals that are now qualified to accept responsibility for graduate training in general surgery and the surgical specialties:

Dallas B. Phemister, Chicago, *Chairman*
Donald C. Balfour, Rochester, Minnesota
John R. Fraser, Montreal
Albert C. Furstenberg, Ann Arbor
Harry S. Gradle, Chicago
Evarts A. Graham, St. Louis
Howard C. Naffziger, San Francisco
Gilbert J. Thomas, Minneapolis
Allen O. Whipple, New York
Philip D. Wilson, New York

The committee will submit in October a report in which will be listed the hospitals which are meeting the criteria, and also those hospitals which with minor adaptations could do so. Periodic surveys will be made to ascertain whether the minimum standard for such training is being adhered to.

Acting on the recommendation of the original Committee on Graduate Training for Surgery, the Board of Regents of the College at a meeting on May 10, 1936, raised the requirements for fellowship as stated in the following extract from the minutes of that date:

BE IT RESOLVED, that applicants for fellowship whose qualifying medical degree shall have been obtained after the date of January 1, 1938, shall be required to present evidence of having completed 3 years of hospital service in one or more acceptable hospitals, of which 2 years shall have been spent in training in surgery in hospitals approved by the American College of Surgeons. In the case of graduates of medical schools which withhold the medical degree until after a fifth year of hospital interneship, the date set will be January 1, 1939.

In justice to all who aspire to future fellowship in the College, there must be assurance that no qualified man shall lack the opportunity to obtain the graduate training required, for there is no desire to set the requirements so high that they cannot be met. As the standard for fellowship goes up, so must the standard for the profession itself be raised. This can be accomplished best at the present time by winning hospital support for wider graduate training opportunities.